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The Bulletin of Animal Health and Production in Africa publishes articles on original research relevant to animal health and production activities which may lead to the improvement of the livestock industry in Africa and better utilisation of her animal resources. The journal is published quarterly.

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Introduction stating the purpose of the work.

Materials and Methods used.

Results presented concisely.

Discussion of significance.

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ORIGINAL ARTICLES

1. Anthelmintic resistance test in gastrointestinal nematodes of small ruminants in southern Ethiopia. K. ASMARE, E. GELAYE and G. AYELET. ......................................................... 89

2. Prevalence of bovine brucellosis in smallholder dairying farming area, Moshi, Tanzania. E.S. SWAI, D. MSHANGA, N.P. SANKA and N.H. MARANDU. ................................................................. 97

3. Claw lesions and lameness in zero-grazed cattle fed on brewer's grain in Uganda J. OKWEE-ACAI and J. ACON ................................................................. 107

4. In sacco degradability of grass hay and rumen characteristics in sheep fed urea ammoniated rice straw or untreated supplemented rice straw. E.O.K. ODDOYE, K. AMANING-KWARTENG, E.K. AWOTWI and J. E. FLEISCHER .................................. 113

5. Evaluation of raw and cooked pigeon pea seed meal as feed ingredient for weaner pigs. E. B. ETUK, CHIDIEBERE, C.P. OPARA, M.C. UCHEGBU, O. O. EMENALOM and B. O. ESONU. ......................................................... 125

SHORT COMMUNICATIONS

6. Prevalence of peste des pestits ruminant (PPR) and helminthiases in sheep and goats in Bauchi, Nigeria. I.S.R. BUTSWAT, D. ZAHRADDEEN and A.S. HUSSAINI. ......................................................... 131

7. Birth weight and gestation length in Hostein-Friesian. MELAKU NEGASH. ......................................................... 135

8. Performance of Bagait cattle under improved and experimental conditions in Eritrea. G. ANDOM. ......................................................... 139

9. Disposal age and culling in Holstein-Friesians. MELAKU NEGASH ......................................................... 143

10. Helminth parasites of domestic pigeons (Columbia livia) in Ibadan, Nigeria. I.O. ADEMOLA and O.A. FAGBOHUN ......................................................... 147
ANTHELMINTIC RESISTANCE TEST IN GASTROINTESTINAL NEMATODES OF SMALL Ruminants in SOUTHERN ETHIOPIA

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TEST DE RESISTANCE A L’ANTHELMINTIQUE CHEZ LES NEMATODES GASTRO-INTESTINAUX DES PETITS Ruminants DANS LE SUD DE L’ETHIOPIE

Résumé

La présente étude a été menée pour examiner la sensibilité des populations de nématodes chez les moutons et les chèvres aux produits contenus dans le bezimidazole, le levamisole et l’ivermectine dans les districts de Hagere-selam, d’Awassa et de Konso au sud de l’Ethiopie. Les résultats de l’enquête avec un questionnaire, effectuée dans deux autres districts : Hosaena et Bele, ont révélé une forte corrélation positive (r = 0.93 ; p<0.05) entre l’origine des anthelmintiques et l’helminthiase qui est une maladie importante des petits ruminants.

On a constaté une réduction du nombre d’œufs de nématodes dans les fèces (100%) avec le benzimidazole et l’ivermectine, et 97,5% avec le tétramisole à Hagere-selam (expérience avec les moutons) ; 99,96% avec le benzimidazole, 98,26% avec le tétramisole et 99,92% avec l’ivermectine au Collège agricole d’Awassa (expérience avec les chèvres) et 99,4% avec le benzimidazole, 98,2% avec le tétramisole et 99,8% avec l’ivermectine à Konso (expérience avec les chèvres). D’après les résultats des expériences, il y a eu une très forte sensibilité dans tous les cas précités à l’exception du tétramisole à Hagere-selam dont la limite de confiance plus faible pour le taux de réduction du nombre d’œufs de nématodes dans les fèces était de 85%, ce qui est considéré comme un cas suspect de résistance.

Mots-clés: Résistance à l’anthelminthique, nématodes gastro-intestinaux, nombre d’œufs dans les fèces, moutons, chèvres, Ethiopie.

Summary

The present study was conducted to investigate the current susceptibility of the parasitic gastrointestinal nematode populations in sheep and goats to the drugs in the Benzimidazole, Levamisole and Avermectin groups, in Hagere-selam, Awassa and Konso districts of southern Ethiopia. The results of the questionnaire survey which included two more districts, Hosaena and Bele, revealed a significant positive correlation (r=0.93; p<0.05) between origin of anthelmintics and helminthiasis as an important disease of small ruminants.

The faecal egg count reduction (FECR) for Bezimidazole and Avermectin plus was 100% and 97.5%, for Tetramisole at Hagere-selam (sheep trial); 99.96% for Bezimidazole, 98.26% for Tetramisole and 99.92% for Avermectin at Awassa college of Agriculture (goat trial) and 99.4% for Benzimidazole, 98.2% for Tetramisole and 99.8% for Avermectin at Konso (goat trial) was detected. Therefore the findings suggest a very good state of sensitivity in all cases, except Tetramisole at Hagere-selam whose lower confidence limit for the faecal egg count reduction percent was 85%, which makes it fall under suspect resistance.

Key words: Anthelmintic resistance, gastrointestinal nematodes, faecal egg count, sheep, goat, Ethiopia.

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Introduction

Nematode infection of the gastrointestinal tract is one of the major causes of wastage and decreased productivity in small ruminants worldwide, particularly under grazing conditions\(^1\). Several anthelmintics with different modes of action are available in the market for the control of helminthiasis. However, the intensive use of these drugs to suppress infestation has resulted in rapid selection of the nematodes for resistance\(^3\).

The first report on anthelmintic resistance to nematodes was reported in sheep and involved Phenothiazine, the commonly used anthelmintics at that time\(^4\). Later, in the early 1980’s anthelmintic resistant nematodes were described in Europe\(^5\). Currently, failure of anthelmintic efficacy due to anthelmintic resistance in sheep and goat nematodes is becoming a widespread threat in Europe, Australia, South America and is of increasing importance in certain African countries like South Africa and Kenya\(^4\). The mechanisms by which parasite resistance develops are not completely understood.

In Ethiopia, the use of anthelmintics in helminth control is known and has been going on for quite a long time, taking a considerable share in drug costs. Smuggling and improper use of veterinary drugs including anthelmintics, is a widespread practice in the country. Despite this, no work has been done so far to elucidate the status of helminth sensitivity to the anthelmintics in use, even though feed-backs from farmers and animal health personnel on the absence of improvement in body conditions of treated animals has been forthcoming. The objectives of the present study were, therefore, to identify the prevailing gastrointestinal nematodes in the study areas and to examine the extent of anthelmintic resistance to the commonly circulating nematocidal drugs.

Materials and Methods

Study area

The work was conducted in three study areas of Southern Nations Nationalities and Peoples Region, Southern Ethiopia. These were Hagere-selam, Awassa and Konso.

Hagere-selam is 372km South of Addis Ababa at an altitude of 3000 meters above sea level (masl). The mean annual rainfall ranges from 1600 to 1999 mm and the mean daily temperature varies between 15 and 19°C\(^6\). Awassa is 275km South of Addis Ababa. It is in the Rift Valley at an altitude of 1680masl. The annual rainfall ranges from 799mm to 981mm and the mean daily temperature is between 20 and 24.9°C\(^6\). Konso is 603 km South of Addis Ababa. The annual rainfall ranges between 517.6mm and 567.6mm and the mean daily temperature ranges between 19.2°C and 21°C\(^6\).

Experimental animals

Caprine studies

Three Hundred male and female goats of different age groups (6 months-3 years) with various blood levels were used in this experiment at Awassa college of Agriculture and in Konso. Deworming has been ongoing there at least twice a year.

Ovine studies

The sheep studies were carried out in Hagere-selam on 150 sheep of ages from 6 months to 3 years, which were held in extensive management system. Over the
years, there has been a history of the use of modern anthelmintics by farmers.

**Study design**

**Questionnaire survey**

A preliminary questionnaire survey was conducted on animal owners and open field market veterinary drug vendors in five areas in the study region (Hagere-selam, Awassa, Bele, Hosaena and Konso). A total of 100 farmers, 20 from each site and a total of 25 illegal veterinary drug vendors, 5 from the respective markets were interviewed. The questionnaire comprised of two parts. In the first part, identification of the farmers, mode of animal husbandry, and livestock constraints were identified. The second part was about the market identification, professional knowledge, common drugs available and their possible sources.

**Experimental procedure**

Goats for the anthelmintic sensitivity trial were selected from Awassa and Konso based on numerical abundances, prevalence of helminthiasis and intensity of anthelmintic usage. During the first visit to the sites, about 150 goats from Awassa college of Agriculture Goat farm and another 150 goats from Konso were selected and ear-tagged on the basis of clinical signs of anaemia, submandibular oedema, soiled hindquarters and poor body condition. At a later stage, these animals were subjected to a screening test using the Modified Flotation Technique\(^{17}\). Subsequent to this, the goats at each site with eggs per gram of faeces above 150 were selected for the experiment. In this way, 60-70 goats were picked from each site and placed randomly into four groups, each consisting of 15-20 animals.

At day 0, following tagging, 10 grams of faeces were collected from the rectum of each animal and kept in labelled polyethylene bags for use in the pre-treatment faecal egg count.

The goats were weighed individually and dosed according to the manufacturers’ recommendations with groups one, two and three being given Albendazole 7.5mg/kg, Tetramisole 15mg/kg, Avermectin 0.2mg/kg and group four being left as the untreated control. At day 10 post-treatment, faecal samples were collected to provide the faecal egg count reduction for each treated group. Additionally, faecal samples were collected from all groups for larval cultures. The same procedures were also applied for the ovine study at Hagere-selam.

**Parasitological techniques**

**Faecal egg count reduction test (FECRT)**

To know the percentage of faecal egg count reduction (%FECR) of each group, faecal egg counts (FEC) of both the pre- and post-treatment faecal samples were performed using the Modified Flotation Method\(^6\).

The percent faecal egg count reduction and the 95% confidence intervals were then calculated using the group arithmetic and geometric mean of the pre- and post-treatment faecal egg counts. The following formulas were used to calculate the %FECR.

1. \[ \text{FECR}(%) = 100\left(1 - \frac{T_2}{C_2}\right) \]

where \(T_2\) (Treated) and \(C_2\) (Control) are the arithmetic mean of post-treatment egg count as recommended by Coles et al\(^{8}\).

The upper and lower 95% confidence limits were calculated using the formula described by Coles et al\(^{8}\).

- **Upper confidence limit** = \[100\left(1 - \frac{X}{X_{\text{exp}}} \exp(-2.048\sqrt{Y^2})\right)\]
- **Lower confidence limit** = \[100\left(1 - \frac{X}{X_{\text{exp}}} \exp(+2.048\sqrt{Y^2})\right)\]
Where $X_t =$ arithmetic mean faecal egg counts of the treatment group
$X_c =$ arithmetic mean faecal egg counts of the control group
$Y^2 =$ the variance of reduction

2. FECR($\%) = 100(1-\frac{T_2}{T_1}) \times \frac{C_1}{C_2}$; where $T$ is treated, $C$ is control; subscripts 1 and 2 are pre-treatment and post-treatment geometric means of EPG.\(^{10}\)

The following formula was then used to calculate the geometric mean.

Geometric mean ($X_g$) = [Antilog of $\Sigma (\log X)/n$] - 1

3. FECR($\%) = \frac{T_1 - T_2}{T_1} \times 100$; where $T_1$ is pre-treatment and $T_2$ is post-treatment arithmetic mean of treated animals.

Resistance to an anthelmintic group is considered to be present if the percentage reduction in egg count was less than 95% and the lower limits of the 95% confidence interval was less than 90% in the first method.\(^{9}\) In methods 2 and 3, resistance is considered to be present if the FECR% is less than 90%.\(^{11}\)

Coproculture
Pre- and post-treatment pooled faecal samples for each group were placed in a wide flask covered with loosely sealed polyethylene bag at room temperature for 7-10 days. Following incubation, the samples were flooded with warm tap water and left to soak.\(^{12}\)

Larval recovery and identification
After 24 hours of Baermannisation, the 3rd stage larvae were recovered and identified based on the procedures as outlined by various authors.\(^{2,12,13}\) Finally the percent of each species in each group was calculated.

Result

Questionnaire survey
The questionnaire based survey was undertaken to elucidate the problem of helminthiasis and the use of anthelmintics. Of the total farmers interviewed, 57% placed helminthiasis as the leading problem (Table 1).

Faecal egg count reduction test (FECRT)
The percentage reduction using only the arithmetic mean of post-treatment faecal egg count and the arithmetic and geometric mean faecal egg counts at day 0 and day 10 for Hagere-selam sheep trial are shown in Table 2, trial. for Awassa College of Agriculture goat

<table>
<thead>
<tr>
<th>Area Surveyed</th>
<th>No. of farmers interviewed</th>
<th>No. of farmers who said helminthiasis was an important problem(%)</th>
<th>No. of drug vendors interviewed</th>
<th>No. of drug vendors agreed anthelmintic top on sale(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H. selam</td>
<td>20</td>
<td>15(75)</td>
<td>5</td>
<td>3(60)</td>
</tr>
<tr>
<td>Awassa</td>
<td>20</td>
<td>13(65)</td>
<td>5</td>
<td>3(60)</td>
</tr>
<tr>
<td>Konso</td>
<td>20</td>
<td>10(50)</td>
<td>5</td>
<td>2(40)</td>
</tr>
<tr>
<td>Bele</td>
<td>20</td>
<td>7(35)</td>
<td>5</td>
<td>1(20)</td>
</tr>
<tr>
<td>Hosaena</td>
<td>20</td>
<td>12(60)</td>
<td>5</td>
<td>3(60)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td><strong>57(57)</strong></td>
<td><strong>25</strong></td>
<td><strong>12(48)</strong></td>
</tr>
</tbody>
</table>
Table 2. Summary of the faecal egg count reduction test analysis by comparing the geometric and arithmetic means of pre (day 0) and post (day 10) treatment samples (sheep) at Hagere-selam.

<table>
<thead>
<tr>
<th>Group</th>
<th>No. of animals</th>
<th>AM-EPG Day 0</th>
<th>AM-EPG Day 10</th>
<th>% FECR</th>
<th>GM-EPG Day 0</th>
<th>GM-EPG Day 10</th>
<th>% FECR</th>
</tr>
</thead>
<tbody>
<tr>
<td>BZ</td>
<td>15</td>
<td>450±14.6(SD)</td>
<td>0</td>
<td>100</td>
<td>117.6±2.87(SD)</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>TET</td>
<td>15</td>
<td>504±16.38(SD)</td>
<td>12.3±6.4(SD)</td>
<td>97.5</td>
<td>429.5±3.3(SD)</td>
<td>1.45±6.12(SD)</td>
<td>85</td>
</tr>
<tr>
<td>AV</td>
<td>15</td>
<td>422.3±16.61(SD)</td>
<td>0</td>
<td>100</td>
<td>305.19±4.3(SD)</td>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>

AM- Arithmetic Mean, GM- Geometric Mean, EPG- Egg Per Gram of faeces, SD- Standard Deviation and FECR- Faecal Egg Count Reduction, BZ- Benzimidazole, TET- Tetramisole and AV- Avermectin

Table 3. Summary of the faecal egg count reduction test analysis by comparing the geometric and arithmetic means of pre (day 0) and post (day 10) treatment samples (goat) at Awassa College of Agriculture.

<table>
<thead>
<tr>
<th>Group</th>
<th>No. of animals</th>
<th>AM-EPG Day 0</th>
<th>AM-EPG Day 10</th>
<th>% FECR</th>
<th>GM-EPG Day 0</th>
<th>GM-EPG Day 10</th>
<th>% FECR</th>
</tr>
</thead>
<tbody>
<tr>
<td>BZ</td>
<td>15</td>
<td>463±17.8(SD)</td>
<td>0.2±0.88(SD)</td>
<td>99.96</td>
<td>370.66±3.54(SD)</td>
<td>1.09±2.5(SD)</td>
<td>99.70</td>
</tr>
<tr>
<td>TET</td>
<td>15</td>
<td>763.7±28.1(SD)</td>
<td>8.6±5.26(SD)</td>
<td>98.87</td>
<td>456.08±3.59(SD)</td>
<td>0.91±5.74(SD)</td>
<td>99.80</td>
</tr>
<tr>
<td>AV</td>
<td>15</td>
<td>422.3±16.61(SD)</td>
<td>0.4±1.55(SD)</td>
<td>99.96</td>
<td>557.9±4.8(SD)</td>
<td>0.14±2.94(SD)</td>
<td>99.97</td>
</tr>
</tbody>
</table>

Table 4. Summary of the faecal egg count reduction test analysis by comparing the geometric and arithmetic means of pre (day 0) and post (day 10) treatment samples (goat) at Konso.

<table>
<thead>
<tr>
<th>Group</th>
<th>No. of animals</th>
<th>AM-EPG Day 0</th>
<th>AM-EPG Day 10</th>
<th>% FECR</th>
<th>GM-EPG Day 0</th>
<th>GM-EPG Day 10</th>
<th>% FECR</th>
</tr>
</thead>
<tbody>
<tr>
<td>BZ</td>
<td>15</td>
<td>383.6±18.5(SD)</td>
<td>2.4±3.4(SD)</td>
<td>99.4</td>
<td>307.08±1.8(SD)</td>
<td>2.12±2.66(SD)</td>
<td>99.7</td>
</tr>
<tr>
<td>TET</td>
<td>15</td>
<td>279.45±14.4(SD)</td>
<td>4.8±7.5(SD)</td>
<td>98.2</td>
<td>262.83±1.58(SD)</td>
<td>2.63±3.53(SD)</td>
<td>99.0</td>
</tr>
<tr>
<td>AV</td>
<td>15</td>
<td>348.8±16.6(SD)</td>
<td>0.8±1.3(SD)</td>
<td>99.5</td>
<td>292.76±1.70(SD)</td>
<td>1.35±1.88(SD)</td>
<td>99.8</td>
</tr>
</tbody>
</table>
trial; Table 3 and for Konso goat trial Table 4. In sheep, efficacy of 100% Bezimidazole (BZ), 97.5% Tetramisole (TET) and 100% Avermectin (AV) was detected. As for Tetramisole, even though the FECR% was found to be 97.5%, the other component of the test criteria, that is the 95% confidence interval, had its lower limits at 85% (Table 2).

The goat trial at Awassa College of Agriculture had efficacy of 99.96%(BZ), 98.26%(TET) and 99.92%(AV) and at Konso 99.41%(BZ), 98.80%(TET) and 99.8%(AV).

**Discussion**

Resistance to anthelminthic is considered to be present if the percentage reduction in faecal egg counts is less than 95% and the lower limit of the 95% confidence interval is less than 90% in the first method. In the second and third methods, resistance is considered to be present if the faecal egg count reduction present is less than 90%10,11. Based on these test criteria, the FECR(%) and the lower confidence limit obtained from Awassa college of Agriculture and Konso Goat farm revealed the absence of a significant level of helminth resistance for all anthelmintics in use. Likewise, the sheep trial from Hagere-selam showed a 100% FECR for Albendazole and Avermectin. As for Tetramisole, the FECR(%) was found to be 97.5% with an 85% lower confidence limit, which makes it fall under suspect resistance. Infact, sensitivity test for Tetramisole using FECR test is difficult, particularly in goats. Tetramisole tends to be less effective against immature stages of *Ostertagia* and it is possible for this stage to mature and begin laying eggs within 10 days between treatment and sampling5. The problem may be compounded in goats by a rapid clearance time and a high incidence of rumen by-pass which can markedly reduce bio-availability14. In this study, more than one method of statistical analysis has been employed in order to assess the consistency of the results. Accordingly, Tetramisole which was thought to be safe in method two and three, was not so in the first method. Moreover, a higher efficacy was obtained when using geometric mean. This was also true in many of the studies that have used geometric means11. Although it is logical and stastically appropriate to use the geometric means, in calculating the mean of the faecal egg count in small ruminants7, it usually gives a higher efficacy of anthelmintics than the arithmetic mean. The latter suggest that not only is the arithmetic mean simpler to calculate and better suited for comparative purposes, but that it is also likely to provide a more conservative 'truer' measure of anthelmintic efficacy than does the geometric mean11.

*Haemonchus* spp. was taking the first place with an average percentage of 53.25% at Hagere-selam, 62.75% at Konso and 74% at Awassa, followed by *Trichostrongylus* spp. 25.5%, 25.75% and 21.25% respectively. *Ostertagia*, *Oesophagostomum* and *Cooperia* spp. were also found with varying degrees in the different sites of the study areas. Thus, one can clearly see how the hematophagus nematode (*Haemonchus* spp.) was dominant even if mixed infections were there as observed earlier15.

The results of this study revealed that anthelmentic resistant nematodes have not yet reached a significant level. Since this attempt was the first of its kind in the region, it is difficult to make a definitive statement about the cause of efficacy failure.
Acknowledgements

The authors are very much grateful to the veterinarians working in the study areas, animal owners and veterinary drug vendors for their overall support.

References


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PREVALENCE OF BOVINE BRUCELLOSIS IN SMALLHOLDER DAIRYING FARMING AREA, MOSHI, TANZANIA.

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PREVALENCE DE LA BRUCELLOSE BOVINE DANS LES PETITES EXPLOITATIONS DE BETAIL LAITIER DE LA REGION DE MOSHI EN TANZANIE

Résumé

La prévalence des anticorps contre l’infection de Brucella abortus chez les bovins a été évaluée à l’aide du Test de séro-agglutination pendant le mois d’avril 2003. Des sérums étaient prélevés à 417 bovins laitiers/locaux (de tous âges, sexes et races) élevés dans 113 petites exploitations choisies au hasard. Le mode d’élevage pratiqué pour la majorité du bétail était la stabulation. La prévalence globale des anticorps anti-Brucella abortus était respectivement de 12,2% et 41,9% pour le bétail individuel et les fermes. Les taux réels de séroprévalence selon l’âge étaient d’environ 3,2% total 100 ans – risque. En utilisant le modèle de régression logistique avec effet aléatoire comme méthode analytique, on a constaté que l’alimentation au tourteau de grains de coton, le sexe, l’origine des animaux et les niveaux de sang Exotique étaient liés à la séropositivité à Br. abortus.

Mots-clés: Séroprévalence, Brucella abortus, bétail laitier, facteurs de risque, petite exploitation, Moshi, Tanzanie.

Summary

The prevalence of antibodies to Brucella abortus infection in cattle was estimated by using serum agglutination test (SAT) during the period of April, 2003. Sera were obtained from 417 dairy/local cattle (of all ages, sexes and breeds) that were kept in 113 randomly selected smallholders farms. The majority of the cattle were kept under zero grazing regime. The overall prevalence of antibodies to Br. abortus were 12.2% and 41.9% for individual cattle and farms, respectively. True rates basing on the age seroprevalence profile were estimated at 3.2% per 100 cattle years-risk. Using random effect logistic regression model as analytical method, feeding cotton seed cake, sex, source of animals and levels of exotic blood were found to be associated with seropositivity to Br. abortus.

Key words: Seroprevalence, Brucella abortus, Dairy cattle, risk factors, smallholder, Moshi, Tanzania.

Introduction

Brucellosis is highly contagious zoonotic disease characterised by storms of abortion and infertility in a variety of animal species and undulant fever in man1. Prevalence rates from 0-50% are reported from several regions in Tanzania2,3,4,5,6. These variations may be due to difference in the sensitivity and specificity of the test used7. The results may also vary depending on whether the studies were conducted on closely populated or rural animal population farms. Location of farms as defined by ecology and management practices has been implicated with incidence of brucellosis8. Little is known about the management factors influencing Br. abortus infection in cattle in the study

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area. The study was undertaken to determine current bovine brucellosis infection rates and degree of infectivity using specific *Br. abortus* antigen to test the sera of different breeds of varying exotic blood and sexes. In this article, we present the results of a cross-sectional study estimating the prevalence of *Br. abortus* antibodies in mixed crossbred local/dairy cattle from smallholder dairy farms in Moshi, Tanzania. The aim of the study was to estimate the rate of infection of this bacterial agent and explore possible relationship between the agent and some animal/farm level risk factors.

**Materials and Methods**

**Description of study area**

This study was conducted in Tangan-yika Plantation Company farms in Moshi, Northern Tanzania. The area elevation is 2500 ft above sea level and lies between Latitude 03° 30’24 S and Longitude 037° 19’18 E. The population of interest consisted of all smallholder mixed dairy farmers and dairy cows from the five administrative sub-locations (or Camps) of the study farming area. A dairy cow referred to either *Bos taurus* cattle (mainly Ayrshire, Friesian and Jersey) or crosses of these breeds with the *Bos indicus* breed, the indigenous Tanzania short horn Zebu (TSHZ) or Boran. The level of exotic blood varied from first to three filial generation or F1, F2 and F3. The animal husbandry practices included both zero and open grazing systems. Over 60% of the cattle were stall fed throughout the year.

**Study design**

A cross-sectional study was conducted on 113 smallholder farms that were randomly selected from a sampling frame of 300 farms. The list of 300 farms was obtained from Moshi district veterinary office database. Farms for the study were estimated to have on average of 1-4 animals (of all ages and sex) sufficient enough to provide between 113 – 452 animals. This estimated sample size, taking into consideration of ‘design effect’ of 2.0 and α = 0.05 could sufficiently guide in providing reasonably confidence and power to estimate disease incidence/prevalence and detect association between dependent and independent variables.

**Data collection**

A semi-structured (SSQ) questionnaire was designed to comprise mostly closed-ended questions for ease of data collection and thereafter handling and analyses.

One of the authors (ES) collected most animal-level and some farm-level data using the questionnaire on all the selected farms on a single day visit. The information collected concerned farm and animal events that occurred during the last three months (prior to sampling) including disease awareness, farming history and management practices. Some farm-level questions included ‘Farm location’ (whether the farm was located in Camp 3, 8, 9, 10 or 11), frequency of contact with extension officers (coded as rare: less than two visit per year, moderate: three to four visits per year and intensive: more than four visits per year), the owner of the smallholder unit classified by sex (female or male) and whether or not the animal had been zero-grazed or allowed to graze on pasture in the three months prior to sampling. Animal level variables included, age (transformed into age centred to normalise the data), sex, breed, filial generation, source (homebred or brought-in) and method of acquisition of brought-in animals (charity gift, local entrustment credit agreement or Heifer in Trust (HIT), and cash purchase).
Collection of sera and laboratory analysis

During the visit to each farm, blood samples were collected by jugular venipuncture into 10ml 'vacutainer' tubes (Becton Dickson, UK) from cattle of all ages, breeds and sexes on the farm during the month of April, 2003. A total of 417 sera were collected and these were carefully labelled and transported in a cool box to Veterinary Investigation Centre (VIC) laboratory and kept over night. Aliquots of sera were obtained by centrifugation at 3000g for 20 minutes. Sera were then stored at –20°C until assayed. The slow Serum Agglutination Test (SAT) was conducted on all sera using 0.85% sodium chloride containing 0.5% phenol as diluent\textsuperscript{10}. Sensitivity and specificity of SAT is thought to range between 60 to 70%\textsuperscript{11} and is lower than the other recommended confirmatory tests for brucellosis such as enzyme–linkage immuno sorbent assay (ELISA), Compliment Fixation Test (CFT)\textsuperscript{12,13}. The antigen was obtained from Animal Disease Research Institute (ADRI), Tanzania. Animals were classified as seropositive if agglutination titre were equal to or above (≥ 1: 80), seronegative (≥ 1: 20) and doubtful (≥ 1: 40)\textsuperscript{10}.

Statistical methods

Association between explanatory (independent) variables and outcome (dependent) variable (sero-conversion to \textit{Br. abortus}) were investigated in two steps by logistic regression\textsuperscript{14} with ‘farm’ as a random effect because animals on one farm may not be statistically independent of one another\textsuperscript{15}. In the first step, relationships between each explanatory and outcome variable were individually investigated in univariate models. In the second step, any variables that were significantly associated at the $F < 0.25$ level were included in multivariable models and through forward and backward elimination, the most parsimonious models in which all explanatory variables remained significant at the P < 0.05 level were generated. Two-way interaction between selected explanatory variables and with the fixed effect of level of exotic blood was assessed and the relationship explored.

Forces of infection (True rates) were estimated from age sero-prevalence profiles using Maximum Likelihood Methods (MLM) in Excel (Microsoft, USA) with solver add-in as previously described\textsuperscript{16}.

Results

Farm response rate

All the 113 farms selected were visited and all the farmers consented to participate were interviewed giving a 100% voluntary response rate. The information of the total of 368 (88.2%) dairy and 49 (11.7%) local cattle animals kept on 96 (85%) and 17 (15%) farms respectively, were recorded and sera collected. The average dairy animals herd size was 3.8 ± 0.18 (mean ± SE) and ranged from 1 to 9 animals whereas the mean local cattle herd size was 2.8 ± 0.16 (mean ± SE) with range varying from 1-17 animals. The distribution of cattle amongst categories of each variable investigated is summarised in Table 1.

Serological responses to \textit{Br. abortus}

Of the 417 animals tested, serology results (positives or negatives) were available from 368 animals and the 49 animals were classified as doubtful reactors. Doubtful reactors were not included in the following analyses. The overall sero prevalence of antibodies to \textit{Br. abortus} was 12.2% (CI, 9.06, 16.01). The corresponding farm/herd sero–prevalence rate was 41.9. % (CI, 30.5, 53.9). Although the proportion of female animals was 73.6% of the total animals ex-
Table 1: The proportions of cattle (N=417) in each category of each variable investigated during the study in Moshi, Tanzania (April 2003).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Categories</th>
<th>Number of animals (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Animal level variables</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td>Male</td>
<td>109(26.1)</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>307(73.6)</td>
</tr>
<tr>
<td></td>
<td>Castrate</td>
<td>1(0.2)</td>
</tr>
<tr>
<td>Source of animal</td>
<td>Homebred</td>
<td>290 (69.5)</td>
</tr>
<tr>
<td></td>
<td>Brought-in</td>
<td>127 (30.5)</td>
</tr>
<tr>
<td>Mode of acquisition (N=127)</td>
<td>Bought cash</td>
<td>111 (26.9)</td>
</tr>
<tr>
<td></td>
<td>Credit (HIT)</td>
<td>5 (1.2)</td>
</tr>
<tr>
<td></td>
<td>Others (gift)</td>
<td>11 (2.7)</td>
</tr>
<tr>
<td>Filial generation</td>
<td>F1</td>
<td>52 (12.5)</td>
</tr>
<tr>
<td></td>
<td>F2</td>
<td>61 (14.6)</td>
</tr>
<tr>
<td></td>
<td>F3</td>
<td>134 (32.4)</td>
</tr>
<tr>
<td></td>
<td>Exotic</td>
<td>121 (29.0)</td>
</tr>
<tr>
<td></td>
<td>Local</td>
<td>49 (11.8)</td>
</tr>
<tr>
<td>Breed codes</td>
<td>Ayrshire cross</td>
<td>236 (56)</td>
</tr>
<tr>
<td></td>
<td>Friesian cross</td>
<td>303 (72.7)</td>
</tr>
<tr>
<td></td>
<td>Jersey cross</td>
<td>30 (7.2)</td>
</tr>
<tr>
<td></td>
<td>TSHZ cross</td>
<td>217 (52.0)</td>
</tr>
<tr>
<td></td>
<td>Boran cross</td>
<td>13 (3.1)</td>
</tr>
<tr>
<td>Age</td>
<td>&lt; 3 years</td>
<td>219 (52.6)</td>
</tr>
<tr>
<td></td>
<td>3 to &lt; 6 years</td>
<td>90 (21.6)</td>
</tr>
<tr>
<td></td>
<td>&gt; 6 years</td>
<td>108 (25.8)</td>
</tr>
<tr>
<td><strong>Farm levels variables</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farm location</td>
<td>Camp3</td>
<td>173 (17.3)</td>
</tr>
<tr>
<td></td>
<td>Camp8</td>
<td>7 (1.6)</td>
</tr>
<tr>
<td></td>
<td>Camp9</td>
<td>147 (35.3)</td>
</tr>
<tr>
<td></td>
<td>Camp10</td>
<td>72 (17.2)</td>
</tr>
<tr>
<td></td>
<td>Camp11</td>
<td>18 (4.3)</td>
</tr>
<tr>
<td>Vaccination S.19</td>
<td>Yes</td>
<td>0 (0)</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>417 (100)</td>
</tr>
<tr>
<td>Farming experience (N=113)</td>
<td>&gt;15 yrs</td>
<td>3 (2.6)</td>
</tr>
<tr>
<td></td>
<td>&gt;5 to &lt;15 yrs</td>
<td>22 (19.4)</td>
</tr>
<tr>
<td></td>
<td>&lt;5 yrs</td>
<td>88 (77.8)</td>
</tr>
<tr>
<td>Grazing history in 2003</td>
<td>Zero grazing</td>
<td>275 (66)</td>
</tr>
<tr>
<td></td>
<td>Grazing</td>
<td>108 (26)</td>
</tr>
<tr>
<td></td>
<td>Semi/free grazing</td>
<td>34 (8.1)</td>
</tr>
<tr>
<td>Owners gender</td>
<td>Female</td>
<td>101 (24.2)</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>312 (74.8)</td>
</tr>
<tr>
<td></td>
<td>Other (Church)</td>
<td>4 (1.0)</td>
</tr>
<tr>
<td>Frequency of extension officer contact</td>
<td>Rare</td>
<td>0 (0)</td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td>226 (54)</td>
</tr>
<tr>
<td></td>
<td>Intensive</td>
<td>191 (46)</td>
</tr>
</tbody>
</table>
minated, the number of female reactors was significantly (P<0.05) higher (14.17%) than males (7.07%). The prevalence was significantly (P<0.05) higher in brought-in animals (18.09%) than in home-bred animals (9.9%), Table 2. The level of seropositive farms/herds ranges from 0-100% and prevalence between Administrative localities (camps) ranged from 0 - 70% (Table 3). The estimated force of infection was 0.032 per animal years-risk. The age sero-prevalence relationship and the forces of infection (True Rates) are shown in Figure 1.

Factors associated with sero-conversion to *Br. abortus*

**Univariate analysis**

In univariate analysis, feeding on cotton seed cake (CSC), higher level of exotic blood, sex, source of animals and the Friesian breed were all significantly (P < 0.05) associated with seroprevalence of antibodies to *Br. abortus* (Table 4).

Brought-in animals were significantly more likely to be sero-positive than animals obtained on credit or gift (Odd ratio [OR] = 2.5, P = 0.026). Animals with greater levels of exotic breed 'blood' (F3 animals) were more likely to be sero-positive than F1 and F2, with local cattle being protective against seroconversion (F3 OR = 4.2, P = 0.021, Local OR = 0.33, P = 0.337). Male stocks were significantly less likely to be seropositive (OR = 0.35, P = 0.047) compared to female stocks.

Friesian breed and animals fed cotton seed cake were more likely to be seropositive (Friesian OR = 4.3, OR for CSC = 3.03, P = 0.05).

**Multivariate analysis**

The variables that remained significantly associated with sero-positivity to *Br. abortus* in the most parsimonious multivariable regression model are summarised in Table 4. Bought or cash acquired animals were more likely to be sero-positive

Figure 1. Force of infection estimates (λ=0.032) for *Br. abortus* infection in dairy cattle - (April, 2003).

MLH estimate of force of infection = 0.032
than animals obtained on credit or gift (OR = 2.62, P = 0.028) as were cattle fed on cotton seed cake compared to maize or millet (OR = 2.82, P = 0.035). Seroprevalence varied significantly with levels of exotic blood with the highest prevalence occurring in F3 and the lowest occurring in indigenous cattle stock (OR for F3 = 5.4, P = 0.001 and OR for Local = 0.53, P = 0.590). Feeding of cotton seed cake and level of exotic blood interaction, revealed that animals with higher levels of exotic blood (F3) showed significantly (P = 0.032) high odds of infection compared to either F1 or F3 or TSHZ breeds.

The study showed that there was evidence of wide-spread exposure to Br. abortus within the Camps studied. Distribution of Br. abortus infection was limited to Camp 3, 8, 9, 10 and no single animal sero-converted in Camp 11. The seropositive results suggested the existence of a past or present

Table 2: Seroprevalence of antibodies to Br. abortus infection in cattle by sex and source.

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Category</th>
<th>Age sub-category</th>
<th>No. tested</th>
<th>No. positive</th>
<th>Doubtful reactors</th>
<th>Prevalence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>Female</td>
<td>1-3</td>
<td>142</td>
<td>19</td>
<td>16</td>
<td>15.07</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;3 to 6</td>
<td>90</td>
<td>10</td>
<td>10</td>
<td>12.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;6</td>
<td>75</td>
<td>9</td>
<td>13</td>
<td>14.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sub-total</td>
<td>307</td>
<td>38</td>
<td>39</td>
<td>14.17</td>
</tr>
<tr>
<td>Male</td>
<td></td>
<td>1-3</td>
<td>97</td>
<td>5</td>
<td>9</td>
<td>5.68</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;3 to 6</td>
<td>6</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;6</td>
<td>6</td>
<td>2</td>
<td>0</td>
<td>33.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sub-total</td>
<td>109</td>
<td>7</td>
<td>10</td>
<td>7.07</td>
</tr>
<tr>
<td>Source of animal</td>
<td></td>
<td>Homebred</td>
<td>290</td>
<td>26</td>
<td>27</td>
<td>9.90</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Brought-inn</td>
<td>127</td>
<td>19</td>
<td>22</td>
<td>18.09</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Overall</td>
<td>417</td>
<td>45</td>
<td>49</td>
<td>12.22</td>
</tr>
</tbody>
</table>

a,b: Significantly different (p<0.05)

Table 3: Seroprevalence of antibodies to Br. abortus infection in cattle by location and farm.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Categories</th>
<th>Number tested</th>
<th>Number positive</th>
<th>Doubtful reactors</th>
<th>Prevalence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administrative location</td>
<td>Camp 3</td>
<td>47</td>
<td>7</td>
<td>17</td>
<td>23.3</td>
</tr>
<tr>
<td></td>
<td>Camp 8</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Camp 9</td>
<td>41</td>
<td>16</td>
<td>15</td>
<td>61.5</td>
</tr>
<tr>
<td></td>
<td>Camp 10</td>
<td>16</td>
<td>7</td>
<td>6</td>
<td>70.0</td>
</tr>
<tr>
<td></td>
<td>Camp 11</td>
<td>477</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Overall Farm</td>
<td></td>
<td>113</td>
<td>31</td>
<td>39</td>
<td>41.9</td>
</tr>
</tbody>
</table>

*Significantly different (p<0.05).
infection, since brucellosis vaccination is not routine and it has never been carried out in the farms over the last ten years (Mshanga, Personal communication). The lower observed inoculation rates (force of infection) in the light of this finding may predict for enhanced genetically based immunity to *Br. abortus* characteristic of Zebu crosses, which act to affect low inoculation rates of this *Brucella* bacterial pathogen.

Since Artificial Insemination is not practiced in the study areas and the fact that the prevalence in bulls was relatively high, it was likely that bulls were associated with protective effect in sero-conversion against *Br. abortus* infection. In many past studies, bulls have been associated with transmission of infection. In the light of findings from this study, the association was not clear, however, it was noted that breeding bulls were not many in this area of study. Detailed investigation may be required to verify the role of breeding bulls in transmitting the infection.

Sero-prevalence varied with the mode of acquisition of the animals. Accounting for breed effect, brought-in-animals were more likely to be sero-positive for *Br. abortus* than were homebred animals. This finding is consistent with studies carried out in Central

| Table 4: Factors found to be significantly associated with the likelihood that cattle sero-convert to *Br. abortus* in univariable, and a minimal multivariable logistic regression models. |

<table>
<thead>
<tr>
<th>Factor</th>
<th>( \beta ) (SE)</th>
<th>OR</th>
<th>Lower – Upper 95% CI</th>
<th>Wald P</th>
<th>Likelihood ratio P value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Univariable analysis</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>-3.2(0.599)</td>
<td></td>
<td></td>
<td>0.052</td>
<td>0.021</td>
</tr>
<tr>
<td>Breeding:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F1 (vs Exotic pure)</td>
<td>-0.01(0.84)</td>
<td>0.99</td>
<td>0.18 - 5.25</td>
<td>0.993</td>
<td></td>
</tr>
<tr>
<td>F2 (vs Exotic pure)</td>
<td>-0.70(0.74)</td>
<td>2.02</td>
<td>0.47 - 8.72</td>
<td>0.343</td>
<td></td>
</tr>
<tr>
<td>F3 (vs Exotic pure)</td>
<td>1.43(0.62)</td>
<td>4.21</td>
<td>1.23 - 14.3</td>
<td>0.021</td>
<td></td>
</tr>
<tr>
<td>TSHZ (vs Exotic pure)</td>
<td>-1.08(1.13)</td>
<td>0.33</td>
<td>0.03 - 3.11</td>
<td>0.337</td>
<td></td>
</tr>
<tr>
<td>Feeding: CSC (Yes vs No)</td>
<td>1.11(0.47)</td>
<td>3.03</td>
<td>1.19 - 7.07</td>
<td>0.019</td>
<td></td>
</tr>
<tr>
<td>Bought –cash (Yes vs No)</td>
<td>0.95(0.42)</td>
<td>2.59</td>
<td>1.12 - 5.97</td>
<td>0.026</td>
<td></td>
</tr>
<tr>
<td>Friesian blood (Yes vs No)</td>
<td>1.47(0.63)</td>
<td>4.37</td>
<td>1.26 - 15.06</td>
<td>0.019</td>
<td></td>
</tr>
<tr>
<td>Animal sex (M vs F)</td>
<td>-1.03(0.52)</td>
<td>0.35</td>
<td>0.12 - 0.96</td>
<td>0.047</td>
<td></td>
</tr>
<tr>
<td><strong>Minimal multivariable model</strong></td>
<td>Constant</td>
<td>-3.19(0.59)</td>
<td></td>
<td>0.045</td>
<td>0.028</td>
</tr>
<tr>
<td>Breeding:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F1 (vs Exotic pure)</td>
<td>0.60(0.85)</td>
<td>1.82</td>
<td>0.34 - 9.73</td>
<td>0.488</td>
<td></td>
</tr>
<tr>
<td>F2 (vs Exotic pure)</td>
<td>1.01(0.75)</td>
<td>2.75</td>
<td>0.63 - 11.99</td>
<td>0.177</td>
<td></td>
</tr>
<tr>
<td>F3 (vs Exotic pure)</td>
<td>1.69(0.63)</td>
<td>5.43</td>
<td>1.57 - 18.81</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>TSHZ (vs Exotic pure)</td>
<td>-0.62(1.1)</td>
<td>0.53</td>
<td>0.05 - 5.25</td>
<td>0.590</td>
<td></td>
</tr>
<tr>
<td>Feeding: CSC (Yes vs No)</td>
<td>1.03(0.49)</td>
<td>2.82</td>
<td>1.07 - 7.43</td>
<td>0.035</td>
<td></td>
</tr>
<tr>
<td>Bought cash (Yes vs No)</td>
<td>0.96(0.44)</td>
<td>2.62</td>
<td>1.10 - 6.20</td>
<td>0.028</td>
<td></td>
</tr>
<tr>
<td>F1* CSC</td>
<td>0.45(0.65)</td>
<td>1.52</td>
<td>0.24 - 6.73</td>
<td>0.381</td>
<td></td>
</tr>
<tr>
<td>F2 * CSC</td>
<td>1.20(0.70)</td>
<td>2.50</td>
<td>0.73 - 9.0</td>
<td>0.152</td>
<td></td>
</tr>
<tr>
<td>F3 * CSC</td>
<td>1.42(0.45)</td>
<td>3.30</td>
<td>1.42 - 11.2</td>
<td>0.032</td>
<td></td>
</tr>
<tr>
<td>TSHZ * CSC</td>
<td>-0.34(1.20)</td>
<td>0.45</td>
<td>0.04 - 4.20</td>
<td>0.490</td>
<td></td>
</tr>
<tr>
<td>Random term</td>
<td>1.26(0.426)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
zone, Tanzania and Libya where brought-in-animals were positive for brucella infection compared to home bred dairy stock\textsuperscript{2,8,17,18}. A study in Libya was based on sheep and goat flock. Of the brought-in-animals, those obtained under cash purchase schemes were more likely to be sero-positive for \textit{Br. abortus} than were animals delivered as gift or credit. This finding may suggest that, most farmer dispose off their stock because of various reasons, which include diseases.

Grazing, semi-zero-grazing and zero-grazing management practices were not associated with the increased likelihood that animals were seropositive for \textit{Br. abortus}. This would be consistent with \textit{Br. abortus} being transmitted via other routes rather than contaminated pastures. The high odds of infection for cattle fed on commercial feeds (i.e. cotton seed cake) could be thought as a potential source or vehicle for pathogen transmission to susceptible cattle. When feeding cotton seed cake was considered as an interaction term with level of filial generation, it was apparent that animals with higher levels of exotic blood had significantly higher antibodies than F1, F2 and indigenous Zebu breed. Stratification with interaction demonstrated that animals with high levels of exotic blood are less resistant to primary infection compared to F1 or local indigenous breeds. However, a long-term study is required in order to verify this observation.

The mean \textit{Br. abortus} seroprevalence of 12.2\% was comparable to those reported in studies of smallholder mixed local/dairy cattle in eastern coastal (Dar-es-salaam; 12\%) and Lake Zone (10.2\%) regions of Tanzania where Brucellosis is also considered a major economic important disease to livestock production\textsuperscript{4,5,6}. Similarly, the overall mean seroprevalence in herds to \textit{Br. abortus} (41.9\%) was comparable to the reported prevalence of 46\% in grazed dairy/local cattle in Lake zone areas of Mwanza\textsuperscript{3}. Consistent to this observation, it may be suggested that the epidemiological status of the disease between geographical areas where the disease is thought to exist are broadly similar.

The prevalence sero-positive to \textit{Br. abortus} varied with age, increasing up to 6 years of age. The observed highest increase of reactors in cattle above six years of age is in agreement with other reports\textsuperscript{18,19}.

Although laborious, time consuming and of low sensitivity and specificity, SAT is considered to be the primary diagnostic test for Brucellosis\textsuperscript{12}. Substantial proportions of the cattle tested were doubtful reactors. One potential limitation of wider use of SAT is the poor ability to detect animals in the incubating stage and in the chronic phase of the disease\textsuperscript{20}. The test is also subject to false positive reactions caused by non-specific agglutins and by cross-reacting antibodies evoked by unrelated bacteria\textsuperscript{21}. Probably this might explain for the higher number of doubtful reactors noted in this study. In the light of this finding, it may be assumed that the infection exists in the area of study, since no history of s.19 vaccination was revealed during field survey. However, a better-structured monitoring study is proposed in order to verify some of the findings and the variation noted in this survey. The study has identified potential controllable risk factors, which will prove very valuable in devising long-term disease control strategies.

**Conclusion**

Sero-prevalence was low, however, comparable to others studies but there was evidence of a wide distribution in the study area. Consistent with this, the force of infection was comparatively low and the likelihood of encounter with infection increased with age but not significantly related. The source of animals particularly bought animals may
be more likely to have encountered and recovered from Br. abortus infection. High levels of exotic blood or (F3) were significantly less resistance to Br. abortus infection.

Acknowledgements

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Reference


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CLAW LESIONS AND LAMENESS IN ZERO-GRAZED CATTLE FED ON BREWER'S GRAIN IN UGANDA

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LESIONS DES ONGLONS ET BOITIERIE CHEZ LES BOVINS EN STABULATION NOURRIS DE DRECLES DE BRASSERIE EN OUGANDA

Résumé

Une évaluation des conséquences directes de l'alimentation des bovins en stabulation avec des drêches de brasserie sur les onglons a été faite lors d'une étude conduite dans le district de Kampala. Les pattes de 218 bovins dans 35 unités de stabulation ont été examinées de juin 2003 à juin 2004. Les bovins dans 20/35 unités de stabulation étaient servis de drêches de brasserie, tandis que ceux dans les 15 autres n'en recevaient pas. Les unités étaient soigneusement choisies.

La comparaison des animaux nourris de drêches de brasserie à ceux qui n'en étaient pas servis, a révélé que les lésions dues à la fourbure aiguë étaient deux fois plus fréquentes chez les derniers. Les lésions dues à la fourbure aiguë constituaient 66,6% des lésions observées chez les bovins servis de drêches de brasserie et 33,4% chez les autres qui n'en recevaient pas. Pendant l'enquête qui a duré une année, la boiterie due aux lésions des onglons affectait 36,7% des animaux. Quarante-sept pour-cent (47,8%) des bovins nourris de drêches de brasserie souffraient de boiterie à cause des lésions des onglons, comparé à 24% chez ceux qui n'en recevaient pas. La boiterie était fortement liée à l'alimentation avec des drêches de brasserie ($\chi^2_{(0,05; 1)} = 3,84 < 13,86$ ; RP = 2,86).

Il a été conclu que les lésions dues à la fourbure aiguë sont les principales causes de boiterie à Kampala ; par ailleurs, la boiterie constitue un problème majeur chez les bovins servis de rations contenant une forte proportion de drêches de brasserie.

Mots-clés: Bovins en stabulation, drêche de brasserie, fourbure aiguë, boiterie, élevage périurbain.

Summary

An assessment of the direct consequences of feeding brewer's grain on claws of zero-grazed cattle was undertaken in an incidence study in Kampala District. Feet from 218 cattle in 35 zero-grazing units were studied from June 2003 to June 2004. Cattle in 20 of the zero-grazing units were fed brewer's grain while 15 of the units did not feed brewer's grain. The units were conveniently selected.

Comparing brewer's grain fed and non-grain fed animals, the prevalence of laminitis associated lesions was doubled in the former. Laminitis-associated lesions constituted 66.6% of all lesions in cattle fed on brewer's grain and 33.4% in those not fed brewer's grain. Within the one year of investigation, 36.7% of the animals studied suffered lameness as a result of claw lesions. Forty-seven percent (47.8%) of cattle fed on brewer's grain suffered from lameness due to claw lesions compared to 24.0% of those not fed on brewer's grain. Lameness was strongly associated with the feeding of brewer's grain ($\chi^2_{(0,05; 1)} = 3.84 < 13.86$, OR=2.86).

It was concluded that laminitis-associated lesions are the leading causes of lameness in Kampala and that lameness is a significant problem in cattle on rations comprising high amounts of brewer's grain.

Key words: Zero-grazed cattle, brewer's grain, laminitis, lameness, peri-urban farming.

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Introduction

Shortage in animal feeds is a major problem facing the livestock industry in most developing countries. This shortage is forcing animal producers to look for less costly alternative sources of feeds in order to realise reasonable returns from their investments. The use of crop residues and agro-processing by-products has been regarded as the turning point in solving the feed problem in developing countries. Offering by-products for use as animal feeds is an economical and environmentally sound way of waste disposal. The industrialist is saved the waste management costs while the farmer benefits from free or rather cheap industrial by-product as feeds. In East Africa, some of the agro-processing by-products used as cattle feed supplements include maize or rice bran, oil seed cakes, molasses and brewer's grain.

Brewer's grain, which is rich fermentable carbohydrate, is widely used as feedstuff for livestock. A survey in Uganda revealed that over 60% of smallholder dairy farmers in and around Kampala heavily utilise brewer's grain to feed their cattle. Carbohydrate nutrition is, however, one of the most challenging aspects of dairy cattle husbandry. Insensible feeding of fermentable carbohydrate may lead to lactic acidosis and associated laminitis. An increase in grain feeding accompanied by low roughage intake is responsible for most lameness cases in dairy cows and has been over-emphasised as the most significant factor in the epidemiology of bovine lameness.

Lameness is increasingly being recognised as one of the most costly disease conditions affecting dairy herds and its prevention and control is essential if a dairy herd is to return a profit. The biggest cause of lameness in dairy cattle is laminitis attributable to irrational carbohydrate nutrition. Laminitis is a multifactorial metabolic disorder whose principal cause is grain feeding. Manifestations of laminitis include sole haemorrhages and discoloration, double soles, flat sole, broadened white line, dorsal wall concavity and ridging. Others include increased incidences of sole ulcer, claw sepsis, sole under-runs and white line abscesses.

An assessment of the direct consequences of brewer's grain as a predisposing factor in the causation and epidemiology of bovine laminitis-associated lameness in the Ugandan settings is absent. This study aimed at qualitatively and quantitatively comparing bovine laminitis-associated lesions and lameness in urban and peri-urban zero-grazing units utilising and those not utilising brewer's grain to feed cattle in Kampala District.

Materials and methods

Selection of farms and animals

Feet from 218 dairy cows aged above 2 to 4 years old from 35 zero-grazing units in and around Kampala District were studied from June 2003 to June 2004. Twenty of the zero-grazing units were utilising brewer's grain to feed cattle while 15 of the units were not. The units were conveniently selected depending on whether they utilised brewer's grain or not. Only animals that showed no evidence of lameness and laminitis-associated lesions were selected for study. Each selected animal was examined every month for the duration of study. Animals diagnosed with laminitis-associated lesions were excluded from subsequent examinations.
Table 1: The Prevalence of lameness in brewer’s grain and non-grain fed cattle in Kampala.

<table>
<thead>
<tr>
<th>Lameness</th>
<th>No lameness</th>
<th>Totals</th>
<th>Incidence(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brewer’s grain fed cattle</td>
<td>55</td>
<td>60</td>
<td>115</td>
</tr>
<tr>
<td>Non-grain fed cattle</td>
<td>25</td>
<td>78</td>
<td>103</td>
</tr>
<tr>
<td>Totals</td>
<td>80</td>
<td>138</td>
<td>218</td>
</tr>
</tbody>
</table>

$\chi^2 (0.05,1) = 3.84 < \chi^2_{1.05} = 3.86, \text{Os}=2.86, n=218$

Table 2: Prevalence of claw lesions in zero-grazed cattle in Kampala

<table>
<thead>
<tr>
<th>Incidence(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grain fed cattle (n=115)</td>
</tr>
<tr>
<td>--------------------------</td>
</tr>
<tr>
<td>Sole ulcer</td>
</tr>
<tr>
<td>Flat sole</td>
</tr>
<tr>
<td>Double sole</td>
</tr>
<tr>
<td>Growth rings</td>
</tr>
<tr>
<td>Septic pododermatitis</td>
</tr>
<tr>
<td>Whiteline abscess</td>
</tr>
<tr>
<td>Over-grown claws</td>
</tr>
<tr>
<td>Under-run sole</td>
</tr>
<tr>
<td>Enlarged white line</td>
</tr>
<tr>
<td>Interdigital hyperplasia</td>
</tr>
<tr>
<td>Sole discoloration</td>
</tr>
<tr>
<td>Digital dermatitis</td>
</tr>
<tr>
<td>Heel erosion</td>
</tr>
<tr>
<td>Foot-rot</td>
</tr>
<tr>
<td>Interdigital foreign body</td>
</tr>
<tr>
<td>Foreign body in the sole</td>
</tr>
<tr>
<td>Wall cracks</td>
</tr>
</tbody>
</table>

n=number of cattle, *=incidence more than doubled in cattle on brewer’s grain.

Data collection

Each animal was observed from the cowshed and any abnormality in gait or posture was recorded and used to categorise it as lame. An animal with a lesion/s on any or all of its claws in addition to having abnormal gait and/or posture was categorised as lame. This was followed by proper restraint in a crush for thorough examination of the claws. Each claw was thoroughly washed with water using a scrubbing brush and examined for various hoof lesions. Hoof tester, hoof knife and probes were used to assist in revealing lesions. Measurements of toe lengths were undertaken from the dorsal skin-horn junction to the apex of the claw using a pair of dividers and rule. An animal with a toe/s longer than 7.5cm was categorised as having over-claw/s.
Data analysis

Data was stored in an EXCEL spreadsheet. A Chi-square test was performed to establish association between the feeding of brewer’s grain and lameness. The strength of this association was measured using odds ratio (OR) statistics.

Results

Feedstuffs in zero-grazing units

The feedstuffs included: cut elephant grass (100%), brewer’s grain (57%), banana peels (56%), maize bran (15%) and other crop residues such as bean or potato leaves (19%).

Prevalence of lameness and claw lesions

The overall prevalence of lameness in zero-grazed cattle in Kampala was 36.7%. Forty-seven percent (47.8%) of cattle fed on brewer’s grain suffered from lameness due to claw lesions while 24.0% of those not fed brewer’s grain suffered from the same. The odds of lameness were tripled (OR=2.86) in cattle fed on brewer’s grain compared to those not fed brewer’s grain. Lameness was strongly associated with feeding of brewer’s grain ($\chi^2 (0.05, 1)=3.84<<<13.86$). The prevalence and OR values for lameness are shown in Table 1.

As shown in Table 2, the prevalence of laminitis-associated lesions including sole

Table 3: Type percentages of foot lesions in zero-grazed cattle in Kampala

<table>
<thead>
<tr>
<th>Lesion</th>
<th>Percentage(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Category fed brewer’s grain</td>
</tr>
<tr>
<td>Sole ulcer</td>
<td>3.3</td>
</tr>
<tr>
<td>Flat sole</td>
<td>10.5</td>
</tr>
<tr>
<td>Double sole</td>
<td>5.4</td>
</tr>
<tr>
<td>Growth rings</td>
<td>10.9</td>
</tr>
<tr>
<td>Septic pododermatitis</td>
<td>4.0</td>
</tr>
<tr>
<td>Whiteline abscess</td>
<td>3.6</td>
</tr>
<tr>
<td>Over-grown claws</td>
<td>15.2</td>
</tr>
<tr>
<td>Under-run sole</td>
<td>4.3</td>
</tr>
<tr>
<td>Enlarged white line</td>
<td>9.4</td>
</tr>
<tr>
<td>Interdigital hyperplasia</td>
<td>1.1</td>
</tr>
<tr>
<td>Sole discoloration</td>
<td>7.6</td>
</tr>
<tr>
<td>Digital dermatitis</td>
<td>0.0</td>
</tr>
<tr>
<td>Heel erosion</td>
<td>21.7</td>
</tr>
<tr>
<td>Foot-rot</td>
<td>0.0</td>
</tr>
<tr>
<td>Interdigital foreign body</td>
<td>0.4</td>
</tr>
<tr>
<td>Foreign body in the sole</td>
<td>0.7</td>
</tr>
<tr>
<td>Wall cracks</td>
<td>1.8</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

*Laminitis-associated lesions doubled in brewer’s grain fed cattle.*
ulcer, double sole, septic pododermatitis, whiteline abscess, over-grown claws, enlarged-whiteline and sole under-runs, were more than doubled in cattle fed on brewer's grain compared to those not fed on brewer's grain. Laminitis-associated lesions constituted 66.6% of all lesions in cattle fed on brewer's grains and 33.4% in those not fed brewer's grain as depicted in Table 3.

Discussion

Crop residues and agro-processing by-products such as brewer's grain form a significant component of the diet of zero-grazed cattle in urban and peri-urban areas of Kampala District. A similar observation has also been reported in earlier studies in Uganda and other regions of the world. Crop residues and agro-processing by-products are widely used as feedstuffs for livestock.

The overall prevalence of lameness estimated at 36.7% was quite high compared to 25%, 5% and 2.7% annual incidence reported for Britain, Israel and Japan, respectively. It is probable that farmers in Kampala are feeding unregulated amounts of grain to cattle compared to their counterparts in the developed world. Intensive dairy husbandry is a recent development in Africa and many farmers therefore still lack expertise. Most farmers in the tropics pay little attention in controlling claw diseases but as development and improvement in management and production takes place, the economic importance of these diseases will be appreciated.

Lameness was strongly associated with the feeding of brewer's grain. Experimental and epidemiological studies have shown that diet and feeding management are of great importance in the control and prevention of lameness and that the biggest cause of lameness in dairy cattle is laminitis attributable to insensible carbohydrate nutrition. Carbohydrate nutrition is probably the most challenging aspect of feeding dairy cows and is the area most commonly associated with lameness. Starch in finely ground high-moisture grain is more rapidly degraded in the rumen leading to increased chances of acidosis and laminitis, hence great caution must be taken when feeding non-structural carbohydrates such as barley or wet finely ground corn. In Kampala, brewer's grain is often fed wet and in unregulated amounts to cattle.

Lesions such as sole ulcer, white line disease, double sole, deep sepsis/claw under-run and claw deformity are directly related to laminitis and are termed laminitis-associated lesions. Laminitis-associated lesions are commonest in animals that suffer subclinical rumen acidosis (SARA), which is a syndrome often resulting from irrational feeding of carbohydrates. In the current study, the overall prevalence of these lesions was doubled (66.6%) in cattle fed on brewer's grain compared to those not fed on grain (33.4%).

It was concluded that, laminitis-associated lesions are the leading cause of lameness in Kampala and that lameness is a significant problem in cattle on rations comprising high amounts of brewer's grain. Further studies are, therefore, needed to establish the composition and feeding regime for brewer's grain so that a campaign may be amounted to educate farmers on appropriate utilisation of this feedstuff.

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References


Saunders Philadelphia.


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IN SACCO DEGRADABILITY OF GRASS HAY AND RUMEN CHARACTERISTICS IN SHEEP FED UREA AMMONIATED RICE STRAW OR UNTREATED SUPPLEMENTED RICE STRAW

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2 Department of Animal Science, University of Ghana, Legon.

DEGRADABILITE IN SACCO DU FOIN ET CARACTERISTIQUES DU RUMEN CHEZ LES MOUTONS NOURRIS DE PAILLE DE RIZ TRAITEE A L'UREE AMMONIACALE OU DE PAILLE DE RIZ NON TRAITEE

Résumé

L'objet de l'étude était d'examiner les changements dans le rumen et les taux de dégradation du rumen lorsque trois moutons munis d'une fistule dans le rumen étaient nourris de paille de riz traitée à l'urée ammoniacale (régime 1), de paille de riz non-traitée complémentée avec Griffonia simplicifolia (régime 2), avec Jasminum dichotomum (régime 3) ou avec du son de blé (régime 4). Le liquide du rumen était recueilli 3, 6, 9, 12 et 24 heures après l'alimentation afin de déterminer le pH du rumen et l'azote issu de l'ammoniac du rumen. Des sacs plastiques dacron contenant du foin brachchiaire étaient incubés dans le rumen pendant 3, 6, 12, 24, 48, 72, 96 et 120 heures. La disparition de la matière sèche (MS) et de la fibre au détergent neutre (NDF), ainsi que les taux de dégradation étaient déterminés. Le pH du rumen des régimes 1 et 2 était très différent (P<0,05) du pH du rumen des régimes 3 et 4. Cependant, l'azote issu de l'ammoniac du rumen n'était pas affecté par le régime servi (P>0,05). S'agissant de la dégradabilité de la matière sèche, la fraction potentiellement dégradable (b) et la dégradabilité éventuelle (a+b) étaient beaucoup affectées par le régime servi (P<0,05). Concernant la dégradabilité de la fibre au détergent neutre, l'interception (a) la fraction potentiellement dégradable (b) et le décalage étaient tous fortement affectés par le régime servi (P<0,05). Il a été conclu que la complémentation de la paille de riz non-traitée avec des compléments appropriés donne des résultats comparables à l'alimentation avec de la paille de riz traitée à l'urée ammoniacale.

Summary

The objective of the study was to examine changes in rumen ecology and rumen degradation kinetics when three rumen fistulated sheep were fed either urea-ammoniated rice straw (Diet 1) or untreated rice straw supplemented with Griffonia simplicifolia (Diet 2), Jasminum dichotomum (Diet 3) or wheat bran (Diet 4). Rumen fluid was collected at 3, 6, 9, 12 and 24 hours after feeding for determination of rumen pH and rumen ammonia nitrogen. Dacron bags containing brachchiaire hay were incubated in the rumen for 3, 6, 12, 24, 48, 72, 96 and 120 hours. Disappearance of dry matter (DM) and neutral detergent fibre (NDF) and degradation kinetics were determined. Rumen pH of Diets 1 and 2 were significantly different (P < 0.05) from the rumen pH of Diets 3 and 4. Rumen ammonia nitrogen was, however, not affected by the diet fed (P > 0.05). For DM degradability the potentially degradable fraction (b) and the potential degradability (a+b) were significantly affected by the diet fed (P < 0.05). For NDF degradability, the intercept (a), potentially degradable fraction (b) and time lag (TL) were all significantly affected by the diet fed (P < 0.05). It was concluded that supplementation of untreated rice straw with appropriate supplements gave results comparable to the feeding of urea-ammoniated rice straw.
Introduction

Fibre-rich, low protein forages and crop residues are the most abundant feeds for ruminants in the tropics and an inefficient rumen ecosystem is probably the first constraint on the productivity of much of Africa’s ruminant population. Strategies to improve utilization of these feeds have therefore aimed at providing (i) supplements to correct nutrient imbalances at the level of the microbes and the animal and (ii) to increase the availability of energy to rumen microbes by “high offer” selective feeding or chemical treatment (e.g. urea ammoniation). The first need is for ammonia, which must be present at greater than 150mg/litre of rumen fluid to maximize intake as well as digestibility¹,².

Urea ammoniation of rice straw is gaining popularity in Ghana as a way of increasing intake of rice straw and also as a way of supplying nitrogen to the animal. Supplementation of poor quality tropical forages (straws and stovers) with foliage from multi-purpose trees or leguminous browse has also been shown to improve growth rates and rumen environment in ruminants³,⁴,⁵,⁶,⁷,⁸,⁹,¹⁰. The foliage of these trees maintain their feeding value well into the dry season and are a rich source of nitrogen, minerals and vitamin A precursors. The potential of indigenous Ghanaian browse plants, as supplementary feeds to poor quality grazing, especially in the dry season, has been noted¹¹,¹². This study was therefore designed to compare rumen characteristics and rumen degradation in sheep fed urea-ammoniated rice straw or untreated rice straw fed with wheat bran (common agro-industrial by-product), *Griffonia simplicifolia* (browse legume commonly found in Dangme West District of Accra) or *Jasminum dichotomum* (browse legume commonly found in Dangme East District of Accra).

Materials and methods

The study was carried out at the Agricultural Research Station (ARS), University of Ghana, Legon using three (3) rumen-cannulated wethers (Mean liveweight 23.5 ± 1.78 Kg) in a balanced incomplete block design with diets as treatments.

Diets

Diets fed were:

- a. Urea ammoniated rice straw (*ad libitum*) (Diet 1)
- b. Chopped untreated rice straw (*ad libitum*) supplemented with *Griffonia simplicifolia* (Diet 2).
- c. Chopped untreated rice straw (*ad libitum*) supplemented with *Jasminum dichotomum* (Diet 3).
- d. Chopped untreated rice straw (*ad libitum*) supplemented with wheat bran (Diet 4).

Feedstuffs preparation.

Urea-ammoniated rice straw was prepared by ensiling chopped rice straw (3 cm long) with urea at 6.5% with 40% moisture ¹³ for a week. The ensiled material was then aired for a day and was ready for use. Enough wheat bran for the experiment was procured from a local supplier. *Griffonia simplicifolia* and *Jasminum dichotomum* were cut from the wild every other day. Quantities required for feeding were weighed out immediately and stored in plastic bags for feeding. The very large woody twigs were removed from the foliage but soft green twigs (about 2-3 mm thick) were included.

Management of animals

Sheep were housed in individual metabolism crates and were initially dewormed
with Albendazole (Dapharma, Raamsdonskever, Holland). An adjustment period of 14 days was allowed before measurements were made. Sheep were fed at 7.00am every morning. *Griffonia simplicifolia*, *Jasminum dichotomum* and wheatbran were first fed to the sheep on diets 2, 3 and 4 for one hour after which they were removed and replaced with chopped untreated rice straw. The quantity of the various supplements consumed was noted. Untreated rice straw was available to the sheep until feeding time the next morning. The amount of untreated rice straw that had been eaten was also noted. Urea-ammoniated rice straw was fed at the same time as the supplements and was also available to sheep until feeding time the next morning. The amount of urea-ammoniated rice straw that had been eaten was also noted. The experiment ran for 4 months and diets were randomly allocated so that by the end of the fourth month each animal had been fed each diet once. During the adjustment period the amount of supplement being eaten by each sheep was averaged and fed to that sheep during the measurement phase.

**Collection of rumen fluid**

After the 14 day adjustment period rumen fluid collection was made on day 15. Rumen fluid was collected at 3, 6, 9, 12 and 24 hours after feeding. Rumen fluid was collected using a stomach tube with the aid of a vacuum pump. The fluid was quickly filtered through 3 layers of cheese cloth, stirred and the pH immediately read with a pH metre (Corning 250). The rumen fluid was then acidified with a few drops of concentrated sulphuric acid and stored in a freezer for subsequent analysis of rumen ammonia. Rumen fluid was analysed for ammonia-N by a modified Kjeldahl method \(^{14}\) (digestion with concentrated sulphuric acid omitted).

**Degradaibility studies**

Degradaibility studies started on day 16. Brachiiara hay was ground (2mm screen) and degradabilities of Dry Matter (DM) and Neutral Detergent Fibre (NDF) were studied. About 5.0 g of the sample was weighed into dacron bags (8cm x 12cm; pore size= 25µ) and incubated for 3, 6, 12, 24, 48, 72, 96 and 120 hours. Residual DM and NDF were determined using the appropriate procedures\(^{15,16}\). Dry matter disappearance at zero incubation was determined after immersing bags in water at 39°C for an hour. Degradation constants of DM and NDF were estimated by fitting disappearance (P) from the dacron bag (g kg\(^{-1}\)) to time (t) in hours following an exponential model\(^{17}\) using the non-linear (NLIN) procedure in SAS\(^{18}\) in an iterative least-squares procedure: 

\[ P = a + b (1 - \exp (-c)) \]  

(equation 1)

The resulting constants were used to estimate the potential degradability (PD) using the following equation\(^{17}\):

\[ PD = a + b \]  

(equation 2)

where \(P\) is disappearance of DM or NDF from the dacron bag at time \(t\), \(a\) is the zero time intercept (soluble fraction of the sample), \(b\) is the insoluble but potentially degradable fraction degraded at a rate constant \(c\). The Lag time before the start of degradation (TL) was calculated as:

\[ TL = (\log{(1/c)} \ln[1 - ((w - a)/b)]) \]  

(equation 3)

where \(w\) is the washing loss (degradation at zero time incubation) and \(a\), \(b\) and \(c\) are as in equations 1 and 2.

**Laboratory analysis**

All feeds were oven-dried at 60°C in a forced draught oven for determination of dry matter. Feeds were milled through a 1.0 mm screen and analysed for Nitrogen\(^{15}\) and NDF, Acid detergent fibre (ADF) and Acid detergent lignin (ADL)\(^{16}\). Organic matter was de-
terminated as the weight loss after ignition in a furnace at 550°C for 3 hours. Hemicellulose was calculated as the difference between NDF and ADF. Feeds were analysed for tannins using the protein precipitation method\textsuperscript{14}.

Statistical analysis

The effects of diet on degradability of DM and NDF were assessed using the General Linear Model (GLM) in SAS\textsuperscript{18}. The differences between treatments with respect to rumen ammonia concentration and pH were analysed using repeated measures analyses\textsuperscript{18,19}. Pairwise comparisons of least-square means using a t-test was done and results are presented as least-square means with the appropriate level of significance. Results are also presented graphically in Figures 1-4. In Figure 3, the wash value has been used as a zero hour value in plotting the graph.

Results

Mean intakes (as fed) of *Griffonia simplicifolia*, *Jasminum dichotomum* and wheat bran during the adjustment phase were 265.0 ± 20.48, 257.5 ± 15.87 and 241.8 ± 11.57g respectively.

Differences in the chemical composition of experimental feeds are detailed in Table 1.

Rumen characteristics

Rumen pH

All mean pH values were 6.81 or higher (Table 2). Diet had a significant effect (P < 0.01) on rumen pH. Time X diet interaction was significant for rumen pH (P < 0.001). There was no significant effect (P > 0.05) of diet 3, hours after feeding. The pattern of rumen pH (rise, peak and fall) over the 24-hour period for each diet is shown in Figure 1. At 6 hours after feeding, the pH of

### Table 1. Chemical composition of experimental diets

<table>
<thead>
<tr>
<th>Parameter\textsuperscript{1}</th>
<th>Untreated Rice straw</th>
<th>Urea-ammoniated rice straw</th>
<th><em>Griffonia simplicifolia</em></th>
<th><em>Jasminum dichotomum</em></th>
<th>Wheat bran</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter (g Kg\textsuperscript{-1} DM)</td>
<td>891</td>
<td>872</td>
<td>389</td>
<td>386</td>
<td>843</td>
</tr>
<tr>
<td>Organic matter</td>
<td>818</td>
<td>799</td>
<td>888</td>
<td>895</td>
<td>944</td>
</tr>
<tr>
<td>Crude Protein</td>
<td>44.9</td>
<td>92.9</td>
<td>178.2</td>
<td>139.7</td>
<td>150.3</td>
</tr>
<tr>
<td>NDF</td>
<td>775</td>
<td>726</td>
<td>534</td>
<td>464</td>
<td>441</td>
</tr>
<tr>
<td>ADF</td>
<td>584</td>
<td>626</td>
<td>330</td>
<td>344</td>
<td>125</td>
</tr>
<tr>
<td>ADL</td>
<td>67</td>
<td>53</td>
<td>149</td>
<td>133</td>
<td>37</td>
</tr>
<tr>
<td>Hemicellulose</td>
<td>191</td>
<td>100</td>
<td>204</td>
<td>120</td>
<td>316</td>
</tr>
<tr>
<td>Cellulose</td>
<td>403</td>
<td>444</td>
<td>195</td>
<td>159</td>
<td>89</td>
</tr>
<tr>
<td>Tannins</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2.6</td>
<td>-</td>
</tr>
</tbody>
</table>

\textsuperscript{1}NDF: Neutral detergent fibre; ADF: Acid detergent fibre; ADL: Acid detergent lignin.
diet 4 was significantly different (P < 0.05) from the other diets. At 9 hours after feeding all the diets were significantly different from each other (P < 0.01). Diets 1 and 2 were not significantly different from each other (P > 0.05) at 12 hours post feeding, but were significantly different from the other two diets (P < 0.01). Diets 3 and 4 were also significantly different from each other (P < 0.01). Twenty-four hours after feeding, diet 3 was significantly different (P < 0.01) from the other diets (Figure 1).

Rumen ammonia nitrogen

Mean rumen ammonia nitrogen (mg l⁻¹) ranged from 119.84 (diet 2) to 223.07 (diet 4) (Table 4). Diet had no effect (P > 0.05) on rumen ammonia nitrogen concentration. The diet interaction between time and diet was also not significant (P > 0.05). The pattern of rumen ammonia nitrogen (rise, peak and fall) over the 24-hour period for each diet is shown in Figure 2.

Degradability studies

Degradability of dry matter (DDM)

Degradability of dry matter (Table 3 and Figure 3) was not significantly different (P > 0.05) among diets from 3 to 12 hrs. At 24 hours DDM of diet 1 was significantly lower (P < 0.05) than the other diets. This trend was again noticed from the 72 hr stage onwards (P < 0.001). The potentially degradable fraction (b) as well as potential degradability (PD) were affected by diet (P < 0.05). All other constants were not significantly different (P > 0.05) (Table 3 and Figure 3).

![Figure 1. Rumen pH over a 24-hour period.](image)
Table 2. Rumen characteristics in sheep fed urea-ammoniated rice straw (Diet 1) or untreated rice straw supplemented with either *Griffonia simplicifolia* (Diet 2), *Jasminum dichotomum* (Diet 3) or wheat bran (Diet 4).

<table>
<thead>
<tr>
<th>Rumen characteristics</th>
<th>Diet 1</th>
<th>Diet 2</th>
<th>Diet 3</th>
<th>Diet 4</th>
<th>SED (n=3)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>7.02</td>
<td>6.90</td>
<td>6.27</td>
<td>6.23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum</td>
<td>7.59</td>
<td>7.63</td>
<td>7.30</td>
<td>7.60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>7.25a</td>
<td>7.21a</td>
<td>6.81b</td>
<td>6.81b</td>
<td>0.147 **</td>
<td></td>
</tr>
<tr>
<td>Ammonia (mg N l⁻¹)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>69.70</td>
<td>33.90</td>
<td>101.65</td>
<td>33.90</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum</td>
<td>313.90</td>
<td>289.20</td>
<td>206.69</td>
<td>435.90</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>178.91</td>
<td>119.84</td>
<td>131.64</td>
<td>223.07</td>
<td>107.040 NS</td>
<td></td>
</tr>
</tbody>
</table>

SED: standard error of difference;
NS: not significantly different, P > 0.05;
P < 0.05 *, P < 0.01 **, P < 0.001 ***;
Means in the same row with common postscripts are not significantly different.

Figure 2. Rumen ammonia (mg/L) over a 24-hour period.
Table 3. Rumen degradation of dry matter of Brachiara hay in sheep fed urea-ammoniated rice straw (Diet 1) or untreated rice straw supplemented with either Griffonia simplicifolia (Diet 2), Jasminum dichotomum (Diet 3) or wheat bran (Diet 4).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Diet 1</th>
<th>Diet 2</th>
<th>Diet 3 (n=3)</th>
<th>Diet 4</th>
<th>SED P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter disappearance (g kg⁻¹)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incubation time (h)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wash value = 115</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Degradation constants (g kg⁻¹)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a</td>
<td>53</td>
<td>56</td>
<td>48</td>
<td>57</td>
<td>26.6</td>
</tr>
<tr>
<td>b</td>
<td>488b</td>
<td>669a</td>
<td>628a</td>
<td>603ab</td>
<td>75.9</td>
</tr>
<tr>
<td>PD (a + b)</td>
<td>541b</td>
<td>725a</td>
<td>676ab</td>
<td>660ab</td>
<td>92.8</td>
</tr>
<tr>
<td>c (hr⁻¹)</td>
<td>0.0256</td>
<td>0.0224</td>
<td>0.0313</td>
<td>0.0266</td>
<td>0.01295</td>
</tr>
<tr>
<td>TL (h)</td>
<td>5.4</td>
<td>4.2</td>
<td>3.8</td>
<td>3.9</td>
<td>1.78</td>
</tr>
</tbody>
</table>

* a, intercept; b, potentially degradable component; c, rate of degradation of potentially degradable component; PD, potential degradability; TL, time lag; SED, standard error of the difference.
NS, not significantly different, P > 0.05;
P < 0.05 *, P < 0.01 **, P < 0.001 ***;
Means in the same row with common postscripts are not significantly different.

Figure 3. Rumen degradation of dry matter (g/kg).
Degradability of neutral detergent fibre (DNDF)

Values for time lag indicate that NDF degradation started almost immediately in diets 3 and 4 (Table 4). It took about 3 hours for NDF degradation to begin in the other diets. This is reflected in the significant differences (P < 0.01) between diets 3 and 4 and the others at 3 and 6 hours after the start of incubation (see Figure 4). After 72 hours incubation and beyond, DNDF for diet 1 was significantly lower (P < 0.05) than the other diets (see Figure 4). Neutral detergent fibre has no soluble component (wash value=0) and coupled with lag time this caused a negative value for the rapidly soluble fraction (a) in diets 1 and 2 (Table 4). Values for the rapidly soluble fraction (a) in diets 1 and 2 were therefore significantly different (P < 0.001) from the other diets. There was also a significant difference (P < 0.05) in the potentially degradable fraction (b) among the diets (Table 4).

Discussion

The generally high rumen ammonia nitrogen levels at 3 hours post feeding were indicative of rapid degradation of the supplements and also urea-ammoniated rice straw. Rumen ammonia nitrogen release is an index of rumen proteolytic activity. Two

![Figure 4. Rumen degradation of neutral detergent fibre (g/kg).](image-url)
Table 4. Rumen degradation of neutral detergent fibre (NDF) of Brachiara hay in sheep fed urea-ammoniated rice straw (Diet 1) or untreated rice straw supplemented with either *Griffonia simplicifolia* (Diet 2), *Jasminum dichotomum* (Diet 3) or wheat bran (Diet 4).

<table>
<thead>
<tr>
<th>Parameter*</th>
<th>Diet 1</th>
<th>Diet 2</th>
<th>Diet 3</th>
<th>Diet 4</th>
<th>SED (n=3)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>NDF disappearance (g kg⁻¹)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incubation time (h)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Degradation constants (g kg⁻¹)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a</td>
<td>-41a</td>
<td>-61a</td>
<td>6b</td>
<td>40c</td>
<td>13.9</td>
<td>***</td>
</tr>
<tr>
<td>b</td>
<td>572b</td>
<td>731a</td>
<td>656ab</td>
<td>622b</td>
<td>55.0</td>
<td>*</td>
</tr>
<tr>
<td>PD (a + b)</td>
<td>531</td>
<td>670</td>
<td>662</td>
<td>662</td>
<td>60.9</td>
<td>NS</td>
</tr>
<tr>
<td>c (h⁻¹)</td>
<td>0.0283</td>
<td>0.0275</td>
<td>0.0318</td>
<td>0.0254</td>
<td>0.01106</td>
<td>NS</td>
</tr>
<tr>
<td>TL (h)</td>
<td>2.5a</td>
<td>3.2a</td>
<td>-0.4b</td>
<td>-2.5c</td>
<td>0.65</td>
<td>***</td>
</tr>
</tbody>
</table>

*a, intercept; b, potentially degradable component; c, rate of degradation of potentially degradable component; PD, potential degradability; TL, time lag; SED, standard error of the difference.

NS, not significantly different, P > 0.05; P < 0.05 *, P < 0.01 **, P < 0.001 ***;

Means in the same row with common postscripts are not significantly different.

Factors jointly determine which microorganisms predominate in the rumen ecosystem; type of substrate and rumen pH. When rumen pH falls below the "cellulolysis threshold" (6.0 - 6.1), fibre digestion is depressed. The time and extent to which pH remains below this threshold is an important determinant of bacterial growth rate. In the present study supplements were fed as a pulse dose, that is, once a day at morning feeding, and hence the initial response seen shortly after feeding and then a return to normal until the next feeding time 24 hours later. Urea-ammoniated rice straw was, however, fed as the only diet and with ammonia constantly present rumen pH did not fluctuate much relative to the others and remained fairly high over the 24 hour period. The high initial rumen ammonia level in diet 4 (294.60) and the fairly high level even after 24 hours (144.07) may be explained by the fact that wheat bran contains a lot of soluble carbohydrates and nitrogen which aided rapid microbial growth initially thus providing high levels of rumen ammonia nitrogen and volatile fatty acids. The rumen pH therefore also fell to 6.41 after 12 hours. After exhausting the readily soluble nitrogen the microbes would then turn their attention to materials with a slower release thereby maintaining a reasonably high rumen ammonia level. This slow down in activity is also evidenced by the increase in pH to 7.45, twenty-four hours after feeding. *Griffonia simplicifolia* was degraded fairly rapidly, with most of the nitrogen being readily soluble such that by 9 hours post-feeding the rumen ammonia nitrogen concentration had already dropped below 100 (93.83) and this material may need to be fed twice at about twelve hour intervals for the best results.

The pattern of pH and ammonia release of *Jasminum dichotomum* is more dif-
difficult to interpret. The low pH (6.43) even 24 hours post feeding is indicative of a continued high production of volatile fatty acids (VFA) or a decrease in absorption rate of VFA. The high levels of rumen ammonia nitrogen, for the Jasminum dichotomum supplemented diet, over the 24 hour period (173.78 - 112.36 mg N l⁻¹) also suggest a good pattern of rumen ammonia release probably due to some amount of resistance to rapid microbial breakdown due to the presence of tannins (2.6 g kg⁻¹). It is known that tannins form complexes with protein which lower their fermentation rate in the rumen and this lower fermentation rate may help improve the fermentation of fibrous crop residues, which also ferment slowly²⁰.

There are conflicting reports in the literature as to the relationship between ammonia concentration and ruminal microbial growth. An in vitro study²⁴ indicated that no more than 50 mg l⁻¹ of ammonia is required for maximal microbial growth. In contrast, another study²⁵ reported that in situ degradation rates plateaued at ammonia concentrations in excess of 200 mg l⁻¹ ruminal fluid. Generally, however, it would appear that all the experimental diets provided enough ammonia nitrogen, at least to optimise microbial growth, over a 24 hour period.

A ranking of diets in terms of dry matter or neutral detergent fibre degradability would put diet 1 last. There is a delay in its degradation but once degradation starts it takes place fairly rapidly, quickly reaching the limits of its degradation. The extent of degradation (b, a+b) was therefore low relative to the other diets. This is a reflection on the fact that even though in terms of rumen ammonia diet 1 was not significantly different from the other diets, it lacked readily soluble carbohydrates which are also a prerequisite for rapid microbial growth and colonisation. In fact there must be a synchronisation in the release of nitrogen and soluble carbohydrates for the microbes to operate at an optimum. In experiments to determine which supplements, when added to untreated rice straw, would elicit a response in the degradation rate, it was reported that generally, supplements containing a source of easily fermentable fibre, such as sugar beet pulp, gave the best response²⁶. The leaves of leguminous trees and shrubs may also provide a highly fermentable fibre. When fed increasing amounts of Gliricidia sepium as a supplement to a basal diet of untreated rice straw, sheep ate considerably more of the rice straw²⁷.

It is concluded that the four diets tested are all capable of maintaining a suitable rumen pH and ammonia level for optimum microbial growth. Supplementation of untreated rice straw with leguminous browse such as Griffonia simplicifolia or Jasminum dichotomum or an agro-industrial by-product such as wheat bran is therefore an alternative to urea-ammoniation of rice straw.

Acknowledgements

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References


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EVALUATION OF RAW AND COOKED PIGEON PEA SEED MEAL AS FEED INGREDIENT FOR WEANER PIGS

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Department of Animal Science and Technology Federal University of Technology, P. M. B. 1526, Owerri, Nigeria.

EVALUATION DE LA FARINE DE GRAINES DE POIS DE CAJAN CRUE ET Cuite COMME INGREDIENT DES ALIMENTS POUR DES PORCS AU SEVRAGE

Résumé

Une étude a été menée pendant 42 jours pour évaluer la performance des porcs au sevrage nourris de farine de graines de pois de cajan (Cajanus cajan) crue et cuite. Trois rations expérimentales pour les porcs à la croissance ont été formulées. La ration 1 (ration- témoing) ne contenait pas de farine de graines de pois de cajan (0% FGP), tandis que les rations 2 et 3 contenaient respectivement 20% de farine de graines de pois de cajan crue et cuite. Chacune de ces rations était servie à raison de 5% du poids vif pendant les trois premières semaines et à raison de 7% du poids vif durant les trois dernières semaines de l'étude, à huit porcs au sevrage âgés de dix semaines pesant entre 6,57 kg et 7,10 kg dans un dispositif expérimental complètement randomisé. Les résultats obtenus montraient une forte baisse (P<0,05) du gain pondéral et de la consommation alimentaire chez les porcs au sevrage nourris à la fois de farine de graines de pois de cajan crue et cuite comparé aux porcs servis de ration-témoin. Les porcs nourris de ration de farine de graines de pois de cajan cuite ont enregistré un taux de conversion statistiquement comparable (P>0,05) à ceux soumis à la ration-témoin. Le coût alimentaire/kg de gain pondéral pour les porcs soumis à la ration-témoin était beaucoup (P<0,05) plus faible (98,18N) que pour les porcs servis de rations contenant de la farine de graines de pois de cajan crue (126,15 N) et cuite (123,61 N).

Summary

A study was conducted for 42 days to evaluate the performance of weaner pigs fed raw and cooked pigeon pea (Cajanus cajan) seed meal. Three experimental pig grower diets were formulated such that diet 1 (control diet) contained no pigeon pea seed meal (0% PSM) while diets 2 and 3 contained respectively 20% raw and cooked pigeon pea seed meal. These diets were each offered at 5% body weight for the first three weeks and 7% body weight for the last three weeks of the study to eight (8), 10-week old weaner pigs weighing between 6.57kg – 7.10kg in a completely randomized design experiment. Results obtained indicated a significantly (P<0.05) depressed weight gain and feed intake among weaner pigs fed both raw and cooked pigeon pea seed meal diet compared with pigs on the control diet. Pigs fed cooked pigeon pea seed meal diet, recorded a statistically (P>0.05) comparable feed conversion ratio (FCR) with those on the control diet. Feed cost per kg weight gain for pigs on the control diet was significantly (P<0.05) lower (N98.18) than for raw (N126.15) and cooked (N123.61) pigeon pea seed meal diets.
Introduction

Grain legumes are important sources of protein and sometimes energy for farm animals such as pigs and these include the edible legume, pigeon pea [Cajanus cajan (L) Millsp]. It serves as food for man and animals due to its high yield even under adverse conditions\(^1\). Pigeon pea seed consumption in Nigeria has been quite low, possibly because of the availability of cowpea, which is easier to cook\(^2\). Thus a viable utilization for instance, in the feeding of pigs will ensure not only its optimum production but also the conservation of biodiversity. Depending on variety, the seed of pigeon pea has (18.5 – 31.1% protein), 36 – 66% carbohydrate, 2.0% fat, 6 - 9% crude fibre and 3.8% ash\(^3\).

As with other legumes, pigeon pea seeds contain antinutritional factors. The most nutritionally important is the protease inhibitors; others are tannins, phytic acid, oxalic acid and haemaglutins\(^4\). Pigeon pea contain less protease inhibitors than soybean; it is, however, deficient in the sulphur containing amino acids, methionine and cysteine\(^5\). Some successes have been achieved in reducing protease inhibitors by heat treatment\(^6\). A 100% loss of trypsin inhibitor activity of pigeon pea has been obtained by cooking for 1 hour and 30 minutes, but tannic acid, oxalate and phytate was less affected\(^4\). The advantages of heat processing are clearly seen in trials with pigs\(^7\).

Earlier reports from India indicate that pigs fed raw pigeon pea seeds performed poorly\(^8\) mainly due to trypsin inhibitors, which can be reduced by heat treatment\(^8\). This study aimed at evaluating raw and cooked pigeon pea seed meal in pig grower diet on the performance of weaner pigs.

Materials and methods

Brown coat coloured pigeon pea seeds used for this study were obtained from Umuahia, Abia state, having been sourced from Gboko, Benue state in the middle belt agricultural zone of Nigeria. The seeds were divided into two batches; one batch was milled raw and stored in bags labeled RPM. The second batch was cooked, sun-dried, milled and stored in bags labeled CPSM. Cooking was achieved by immersing pigeon pea seeds in boiling water for 30 minutes in a drum already set on open burning firewood.

Three pig grower rations were then formulated, such that diet 1 (control diet) contained pigeon pea seed meal. Diets 2 and 3 each respectively contained 20% raw (20% RPM) and cooked (20% CPSM) pigeon pea seed meal, replacing 18.18% of maize and 66.66% of soybean meal in the control diet. All diets were isonitrogenous and isocaloric (Table 1).

Each pig grower diet was offered at 5% body weight for the first three weeks and 7% body weight for the last three weeks of the experiments to eight (8), 10-week old weaner pigs in four (4) replicates of two (2) weaner pigs each in a completely randomized design (CRD) experiment giving a total of 24 pigs in all. The feeds were offered to the pigs in 2 equal regimes daily at 08.00 and 16.00 hours. Each replicate was housed in a concrete floor compartment measuring about 1.5m x 1m. The pigs were dewormed with piperazine\(^*\) before the commencement of the trial and water was offered ad libitum throughout the duration of the study.

The pigs were weighed individually at the beginning of the trial and on a weekly basis thereafter. Feed intake was determined indirectly by subtracting any quantity left
over, the following morning from the quantity offered the previous day. The cost of the feed ingredients were also noted and used to compute each treatment feed cost. The feed conversion ratio for each treatment was calculated using data obtained for weight gain and feed intake.

Data obtained were subjected to analysis of variance (ANOVA). Where significant differences were detected, the means were separated using the Least significant difference (LSD)\textsuperscript{10}.

Results

Weaner pigs performance estimated as weight gain indicated that those on the control diet recorded significantly (P<0.05) higher weight gains (10.83kg). Pigs placed on diet containing 20% RPSM recorded 8.80kg while those on diet containing 20% CPSM recorded 8.84 kg as weight gains during the six week duration of the trial. Pigs on 20% CPSM showed a slight though not significant (P>0.05) improvement over those on 20% RPSM diet.

Pigs on the control diet recorded a significantly (P<0.05) higher feed intake (28.59kg) than pigs on 20% RPSM diet (26.39kg) and 20% CPSM (25.88kg) during the six weeks duration of the experiment. Feed intake of pigs on 20% RPSM and 20% CPSM were not significantly (P>0.05) different though pigs on 20% CPSM recorded a slightly lower feed intake.

The 2.64 feed conversion ratio (FCR) recorded by pigs on the control diet was not significantly (P>0.05) different from 2.93 recorded by pigs on 20% CPSM. Weaner pigs on 20% RPSM however registered the highest FCR of 2.99. Surprisingly, feed cost per kg and feed cost per kilogramme weight

<table>
<thead>
<tr>
<th>Table 1. Composition of experimental diets.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Feedstuffs</strong></td>
</tr>
<tr>
<td>****</td>
</tr>
<tr>
<td>Maize</td>
</tr>
<tr>
<td>Soybean meal</td>
</tr>
<tr>
<td>PSM</td>
</tr>
<tr>
<td>Vit/Min. premix**</td>
</tr>
<tr>
<td><strong>Calculated nutrient composition (g kg\textsuperscript{-1})</strong></td>
</tr>
<tr>
<td>Crude protein</td>
</tr>
<tr>
<td>Ether extracts</td>
</tr>
<tr>
<td>Crude fibre</td>
</tr>
<tr>
<td>Methionine</td>
</tr>
<tr>
<td>Lysine</td>
</tr>
<tr>
<td>Calcium</td>
</tr>
<tr>
<td>Phosphorus</td>
</tr>
<tr>
<td>ME (MJ kg\textsuperscript{-1})</td>
</tr>
</tbody>
</table>

PSM = Pigeon pea seed meal, RPSM = Raw pigeon pea seed meal, CPSM = Cooked pigeon pea seed meal.

*Each diet contained the following (g kg\textsuperscript{-1}): Brewers' dried grain - 132.0, Wheat bran - 100.0, Fish meal - 30.0, Lysine - 2.0, Methionine - 1.0, Bone meal - 20.0 and Oyster shell - 7.5, salt - 5.0.

**To provide the following per kg of feed: vitamin A. 10,000 iu; vitamin D\textsubscript{3}, 2000 iu; vitamin E, 5 iu; vitamin K, 2mg; riboflavin, 4.2mg; vitamin B\textsubscript{12}, 0.01mg; pantothenic acid, 5mg; nicotinic acid, 20mg; folic acid, 0.5mg; choline, 3mg; Mg, 56mg; Fe, 20mg; Cu, 1.0mg; Zn, 5.0mg; Co, 1.25mg; Iodine, 0.8mg.
Table 2. Performance of weaner pigs fed raw and cooked pigeon pea seed meal diets

<table>
<thead>
<tr>
<th>Parameters</th>
<th>(0% PSM)</th>
<th>(20% RPSM)</th>
<th>(20% CPSM)</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Av. Initial body weight (kg)</td>
<td>6.57*</td>
<td>7.10*</td>
<td>6.76*</td>
<td>3.38</td>
</tr>
<tr>
<td>Av. Final body weight (kg)</td>
<td>17.40*</td>
<td>15.90*</td>
<td>15.60*</td>
<td>0.74</td>
</tr>
<tr>
<td>Av. Weight gain (kg)</td>
<td>10.83*</td>
<td>8.80b</td>
<td>8.84b</td>
<td>0.52</td>
</tr>
<tr>
<td>Feed intake (kg)</td>
<td>28.59*</td>
<td>26.39b</td>
<td>25.88*</td>
<td>0.58</td>
</tr>
<tr>
<td>FCR (g feed/g gain)</td>
<td>2.64*</td>
<td>2.99b</td>
<td>2.93ab</td>
<td>0.10</td>
</tr>
<tr>
<td>Feed cost (N/kg feed)</td>
<td>37.19*</td>
<td>42.19b</td>
<td>42.19ab</td>
<td>4.98</td>
</tr>
<tr>
<td>Feed cost (N/kg weight gain)</td>
<td>98.18*</td>
<td>126.15b</td>
<td>123.61ab</td>
<td>8.93</td>
</tr>
<tr>
<td>Mortality</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>-</td>
</tr>
</tbody>
</table>

PSM = Pigeon pea seed meal, RPSM = Raw pigeon pea seed meal, CPSM = Cooked pigeon pea seed meal, SEM = Standard error of mean, N = Naira
N 140 = $1.00
*ab means with different superscripts within rows are significantly different (P<0.05).

Gain was significantly (P<0.05) higher for 20% CPSM and 20% RPSM diets than the control diet. Feed cost per kg were N37.19, N42.19, N42.19 while feed cost per kg weight gains were N98.18, N126.15 and N123.61 respectively for the control, 20% RPSM and 20% CPSM diets after boiling for 1 hour 50 minutes. Phytate, being the least affected may have contributed to the low weight gain of weaner pigs on both raw and cooked pigeon seed meal diets. Phytate can form complex with minerals, starch, proteins and digestive enzymes. However, all adverse effect were completely reversed by autoclaving the pigeon peas at 124°C prior to dietary inclusion. Also tannins reduce protein digestibility through the formation of complexes with dietary protein and the inhibition of the activities of proteolytic enzymes in the digestive secretion although has less effect on starch digestibility.

Discussion

This result on weight gains agrees with earlier reports which showed that growing pigs fed raw pigeon pea seed meal performed poorly mainly due to trypsin inhibitors. The results obtained also indicated that cooking, which has been reported to improve pigeon pea seed meal utilization by broilers even at 50% dietary levels in some cases and reducing hen - day production significantly only at 30% dietary level could not significantly improve the weight gain of weaner pigs even at only 20% dietary inclusion level. Weaner pigs, therefore appear to be less tolerant than poultry to the residual protease inhibitors in pigeon pea cooked for 30 minutes. It is also possible that other antinutritional factors like phytate, oxalate and tannins which are not eliminated even...
sition of the treatment diets, the partial replacement of soybean meal with pigeon pea seed meal may have resulted in amino acid imbalance especially with regards to the sulphur containing amino acids, which is deficient in pigeon pea. The amount of amino acids consumed by pigs is determined by feed intake and the digestible energy in the diet, these factors in turn directly influence voluntary feed intake in growing pigs\textsuperscript{16}.

Results of the feed conversion ratio of weaner pigs in this study follow the same trend with earlier reports obtained for broilers fed cooked pigeon pea seed meal as replacement for soybean meal and maize\textsuperscript{17}. The high FCR recorded by pigs on 20\% RPSM diet and 20\% CPSM further indicate the possibility of amino acid and energy imbalance which results in reduced growth, poor feed efficiency and inadequate rate and efficiency of protein and fat deposition\textsuperscript{1}. The higher feed cost per kg and feed cost per kg weight gain of 20\% RPSM diet and 20\% CPSM diets is not unconnected with the astronomical rise in the cost of pigeon pea seeds due to transportation cost and low production by farmers who prefer to cultivate cowpea that is in higher demand. This high feed cost contrasts sharply with the decreasing broiler feed cost with increasing dietary level of pigeon pea seed meal as reported in an earlier study\textsuperscript{18}.

Observations from this study is that pigeon pea seed meal cooked for 30 minutes and included at a level as low as 20\% in weaner pig diet could not support the rapid growth desired. It will therefore be necessary to increase the cooking time and possibly supplement the diet with the deficient sulphur containing amino acid to perhaps improve its nutritive value for growing pigs.

References


Received for publication on 02nd November, 2004.
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SHORT COMMUNICATION

PREVALENCE OF PESTE DES PESTITS RUMINANT (PPR) AND HELMINTHIASIS IN SHEEP AND GOATS IN BAUCHI, NIGERIA

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Abubakar Tafawa Balewa University, P.M.B. 0248, Bauchi, Nigeria.

Animal protein deficiency in the diet of low income Nigerians as a result of the devastation of the sahel by droughts of the past decades and the depletion of beef supply due to rinderpest outbreaks of the 1980's have resulted in a growing need for mutton and goat meat as sources of animal protein1. The small ruminant population in Nigeria currently stands at 26.27 million and 42.01 million for sheep and goats respectively2. The productivity of sheep and goats in the country is generally low due to diseases, poor animal management practices, poor genetic potential and the low level of literacy among farmers3.

Peste des pestits ruminant (PPR) is endemic in most parts of the West African sub-region4. Sheep and goats in all the climatic zones of Nigeria are affected by the disease5. It is estimated that the economic loss due to PPR to be over N 1million annually6 or approximately 20-40 million U.S.7 Dollars. The mortality rate through PPR was put at 85% and a morbidity rate of 40% and the severity of the disease varies between sheep and goats8. Similarly, it has been shown that gastrointestinal helminthiasis in sheep and goats causes losses of up to N 60 million annually9. This study was therefore designed to investigate the prevalence of PPR and helminthiasis in sheep and goats in Bauchi from 1997-2001.

The study was conducted in Bauchi Metropolis and its environs. Bauchi town is located at latitude 10° 17’ North, longitude 8° 49’ East and at an altitude of about 690.2 metres above the sea level and the climate has been described earlier10.

The vegetation of Bauchi is made up of open Savannah woodland12. The grazing management system is mostly traditional and ranges from free-range grazing with limited supplementary feeding to tethering during the cropping seasons10.

The data for this study were collected from Bauchi Main Veterinary Clinic. The data were subjected to chi-square method of statistical analysis using period, sex, species and season as factors, while simple percentages were also used on other relevant measurements13.

The results showed that prevalence rates in the years 1997, 1998, 1999, 2000 and 2001 were 14.38 vs 19.43%, 10.00 vs 10.24%, 14.12 vs 13.29%, 20.74 vs 14.65% and 22.09 vs 20.23% (P<0.05) for the helminth infection and PPR respectively (Table 1). The higher prevalence rates in 1997 and 2001 was in conformity with past findings where it was reported that PPR follows a cyclic pattern with significant increase in incidence rate every 3-4 years14. Similarly, the clinical cases of helminthiasis were at an increase from 1998 to 2001. This gradual increase

* Corresponding author e-mail: zdtabra2003@yahoo.com
Table 1: Prevalence of PPR and helminthiasis in sheep and goats

<table>
<thead>
<tr>
<th></th>
<th>No. of animals affected</th>
<th>Total number of animals</th>
<th>Rate of infection(%)</th>
<th>$\chi^2$</th>
<th>Los</th>
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<tr>
<td>1997</td>
<td>628</td>
<td>4367</td>
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<tr>
<td>1998</td>
<td>466</td>
<td>4658</td>
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<td>1999</td>
<td>779</td>
<td>5516</td>
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<tr>
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<td><strong>PPR with period</strong></td>
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<td>2001</td>
<td>900</td>
<td>4449</td>
<td>20.23</td>
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<td><strong>Helminthiasis in relation to sex</strong></td>
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<td>2959</td>
<td>13630</td>
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<td>2980</td>
<td>12534</td>
<td>23.78</td>
<td></td>
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<td><strong>PPR between species</strong></td>
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<td>Sheep</td>
<td>441</td>
<td>4089</td>
<td>10.79</td>
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<td>Goats</td>
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<td>8110</td>
<td>35.18</td>
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<td><strong>Helminthiasis between species</strong></td>
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<tr>
<td>Sheep</td>
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<td>7074</td>
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<td><strong>PPR in relation to season</strong></td>
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<td>3887</td>
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<td><strong>Helminthiasis in relation to sex</strong></td>
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<tr>
<td>ED</td>
<td>1146</td>
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<td>22.79</td>
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<tr>
<td>LD</td>
<td>598</td>
<td>4545</td>
<td>13.16</td>
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<tr>
<td>ER</td>
<td>822</td>
<td>4577</td>
<td>17.96</td>
<td>8.702</td>
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</tr>
<tr>
<td>LR</td>
<td>1781</td>
<td>5721</td>
<td>31.13</td>
<td></td>
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</tr>
</tbody>
</table>

Los = level of significance

*: P < 0.05
ED = Early dry (October – December)
LD = Late dry (January – March)
ER = Early rain (April – June)
LR = Late rain (July – September)
might have been due to the increased number of small ruminant producers from 466 to 1254 in the locality and the lack of knowledge on deworming.

Data on prevalence rates of these diseases in relation to sex are also shown in Table 1. The results revealed that females (21.71 vs 23.78%) recorded significantly (P<0.05) higher cases of PPR and helminthiasis than the male animals (14.84 vs 10.66%). This is in close agreement with other findings reported that females are more susceptible to diseases than their male counterparts.

Table 1 shows the results on infection rates of PPR and helminthiasis in sheep and goats. The clinical prevalence of PPR in the two species revealed that there was variation in their susceptibility. A total of 10.79 and 35.18% (P<0.05) infection rates were recorded for sheep and goats respectively. This was similar to past finding where sheep were found to be less severely affected than goats. Goats were reported to be often affected by an acute form of the disease but sheep usually suffer from a sub-acute or chronic form.

Sheep were recorded to have significantly higher (P<0.05) helminth infection (32.02%) than the goat species (27.83%), as shown in Table 1. This was contrary to earlier findings where a higher incidence rate was found in goats than in sheep. This variation was probably due to differences in management practice of these animals, where the majority of the animals are kept under the traditional management system with little or no provision of medical care.

Data on seasonal distribution of PPR in the study area are also shown in Table 1. The peak incidence is observed during the late rainy season (July to September), where 29.46% of the total cases were recorded. This contradicts earlier findings where the diseases was encountered the disease all year round with peaks during the wet season (April to June).

The clinical report showed that helminth infections occur during the late rainy (31.13%) and early dry (22.79%) seasons. This agreed with past results that parasites require a period of development outside the host before becoming infective to the hosts.

The study revealed that PPR and helminth infections were seasonally distributed with maximum infections during the wet season. Females exhibited higher infection rates than males, and sheep and goats were both affected by the diseases.

It is therefore suggested that a vaccination programme against PPR at the on set of the rains may drastically reduce the incidence of the disease. Anthelmintics should also be administered at the early dry season to reduce the number of helminths in the animals.

References

International Conference in goats production, Addis Ababa, Ethiopia: 296.


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In general temperate dairy cattle breeds show depression in performance such as milk yield, birth and mature weights, and fitness performances (viz, survival and fertility) when they are brought into the tropics. For instance, birth weight were 28.6 kg from Egypt, 34.6 kg from Iraq and 30.4 kg from Ghana. Gestation length is a rather genetically predetermined trait and normally there is no appreciable difference in the same or even among different cattle breeds. For example, estimates of gestation length for the same cattle breed, i.e. Holstein-Friesian, ranged from 271-281 days from Libya.

In this study both calf birth weight and gestation length are measured and the influence of season and sex of calf on both traits were tested. In addition heritability of both traits were estimated.

The cattle herd is a pure Holstein-Friesian under semi-intensive management where the basal feed comes from grazing and hay feeding. There were 149 birth weight and gestation length records for this study for the period 1992 to 1996.

The following fixed model according to Harvey, where season of calving and sex of calf were included in model, was used for least-square analysis of variance:

\[ Y_{ijk} = \mu + a_i + b_j + e_{ijk} \]

where,

\[ Y_{ijk} = \text{observations of birth weight or gestation length} \]

\[ \mu = \text{overall mean} \]

\[ a_i = \text{effect of season of calving} \]

\[ b_j = \text{effect of sex of calf} \]

\[ e_{ijk} = \text{error or residual term - NID} \sim (0, \sigma^2) \]

Calf birth weight and gestation length were estimated and averaged 39.5±4.5 kg and 279.3±7.9 days, respectively. The weight measure found in this study is 90% of the US standard for the same cattle breed. However, it is quite higher than several estimates made in the tropics for the same cattle breed. For instance, calf birth weight averaged 28.6 kg from Egypt, 30.4 kg from Ghana and 34.3 kg from Iraq. The high birth weight measure found in this study is indicative of the fact that semen or bulls of high producing genotypes are being used extensively. This apparently good measure may not be useful unless we have the improved management it demands. When enough managerial input are not met, traits that suffer most are fitness traits like survival and fertility because they are poorly heritable and environment has the greatest influence on them compared to those of production traits such as milk yield, size or weight.

Gestation length is a rather genetically predetermined trait. The gestation period reported here is comparable to other estimates of the same cattle breed from the tropics. For example, gestation period was 280.1 days from Cuba, 279.9 days from India, similarly 279.9 days from Ghana and
Table 1. Estimated least square means (LSM) with their standard error (SE) for calf birth weight (CBW) and gestation length (GL).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Number</th>
<th>LSM ± SE (CBW, kg)</th>
<th>LSM±SE (GL, days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall mean</td>
<td>149</td>
<td>39.6±0.3</td>
<td>279.3±0.6</td>
</tr>
<tr>
<td>Season of calving</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oct-Jan</td>
<td>56</td>
<td>39.8±0.6</td>
<td>279.5±1.0</td>
</tr>
<tr>
<td>Feb-May</td>
<td>52</td>
<td>38.7±0.6</td>
<td>278.8±1.0</td>
</tr>
<tr>
<td>Jun-Sept</td>
<td>41</td>
<td>40.2±0.7</td>
<td>279.6±1.2</td>
</tr>
<tr>
<td>Sex of calf</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>male</td>
<td>72</td>
<td>40.2±0.5</td>
<td>281.1±0.9</td>
</tr>
<tr>
<td>female</td>
<td>77</td>
<td>39.0±0.5</td>
<td>277.6±0.8</td>
</tr>
</tbody>
</table>

ranged from 277 to 281 days from Libya\(^6\). Analysis of variance of birth weight where season and sex of calf were included in the model failed to show any significant effect of these factors on the variation of birth weight. However, birth weight of male calves was higher (40.2 kg) than female calves (39.0 kg). Again calves born in the long rainy season appeared heavier (40.2 kg) than those born during the short rainy season (38.7) (Table 1); this has to do with availability of grazing in the preceding dry season when the foetus is at its late stage demanding greater energy. Again analysis of variance of gestation length revealed a significant difference of gestation length between sex of calves. Male calves were carried 3.5 days longer than female calves (Table 1). Yet gestation length variations over seasons were small and insignificant.

Heritability of both birth weight and gestation length were estimated and they averaged 0.21± 0.2 and 0.16± 0.15, respectively. The heritability measure found for birth weight was lower than commonly made reports for temperate cattle breeds in the tropics which are in the order of 0.35\(^10\). This means that the influence of additive genes in the variation of birth weight is very low and genetic improvement of birth weight cannot be successful from relying on phenotypic measures. The heritability estimate for gestation length found in this study is rather low although the gestation length is a genetically predetermined trait. Yet it falls between a range of 0.0 to 0.71 found in various cattle breeds\(^11\). The reason heritability measures for gestation length so much deviate from high measures (> 0.6) is rather enigmatic.

The weight measure found for this herd is quite high. This may be due to a heavy use of semen of high quality genotypes. The high birth weight would only be advantageous if management level is optimal; otherwise poor fitness performances, viz. fertility and survival, are unavoidable. The gestation period found is not any different from other estimates signifying that there was no environmental or genetic element affecting it.
Acknowledgements

My thanks goes to Prof. Eskil Brannang from Sweden for his valuable comments. Also my gratitude goes to the Dairy Development Enterprise for the supply of the data material.

References


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A seasonal difference in birth weight was observed in the model, with the effect of season being higher in the fall (40.2 kg) than in the spring (36.3 kg). Again calve's born in the fall season appeared heavier. The average birth weight of calves born during the winter season (38.7 kg) (Table 1); this has led to the possibility of grazing in the preceding dry season, which is the most productive period of the year. The analysis of variance of gestation length revealed a significant difference of gestation length between sex of calves. Male calves were carried 3.3 days longer than female calves (Table 1). The gestation length variation over different periods was small and insignificant.

Heritability of both birth weight and gestation length was estimated and they averaged 0.25 and 0.18, respectively. The heritability estimates for both traits were low, indicating that there was no significant genetic influence on these traits.
SHORT COMMUNICATION

PERFORMANCE OF BAGAIT CATTLE UNDER IMPROVED AND EXPERIMENTAL CONDITIONS IN ERITREA

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Bagait (Barka-erishay) represents the cattle type of the western lowlands of Eritrea. These cattle types are the most numerous and widely distributed in the western lowlands of Eritrea. Economically, the bagaits support the majority of rural families, especially in the pastoral community, by providing food security, income, and investment and, in general, improved standards of living. Like in many parts of sub-Saharan Africa, Bagait cattle type account for most of milk consumed domestically. Production and reproduction of Zebu is known to be low. In range-land condition, milk in first and second lactation were found to be 671±16 and 681±13.5 kg respectively, with lactation length of 184±4 and 178±3.5 days for the first and second lactation. Kinana cattle type of Sudan under rangeland condition recorded a milk yield of 2,570 kg, with a lactation length of 311 day and their dry period of 157 and calving interval of 455 days.

Bagait cattle have been known to produce around 1500 to 1800 liters per lactation under improved environment condition. The present study was conducted to assess the production and reproduction traits of Bagait cattle under natural grazing system. The data utilized for the present study were obtained from 35 lactation records belonging to 15 Bagait cows, maintained in Shamboco Research Station in Gash-Barka Zoba (zone) of lowlands of the State of Eritrea. Lactation records for a period of three years from 1995 to 1997 were carried out in the study. Total lactation milk yield, peak milk yield, lactation length, service period, dry period, gestation length, and calving interval were estimated as per the least squares analysis to overcome the non-orthogonality of the data resulting from unequal sub-class frequencies.

Least square means with the standard errors for various production and reproduction traits in Bagait cattle for milk yield in the first, second and third lactation in the present study were 865±31.25, 770±29.03 and 629±25.05 kg respectively while lactation length for the first, second and third lactation were 280, 230 and 237 days respectively. Average daily milk yield for the first, second and third were 2.95±0.31, 2.80±0.21 and 1.85±0.18 kg respectively. For the reproduction traits, the average of service period, dry period, gestation length and calving interval were 112±10.80, 120±18.16, 283±3.85, and 399±7.95 days respectively.

Means obtained in the present study were comparable with other reports. However, these means were slightly higher than

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those reported on Ongole cattle\textsuperscript{6,10} and less than that reported for Kinana cattle type of Sudan\textsuperscript{4}. The productivity of the Bagait, particularly the Bulaad strain, has attracted some regional researchers and institutions. The Ethiopian Institute of Agricultural Research (Eiar) has conducted several trials on the Bagait breed that included improved management and cross breeding\textsuperscript{11}. These cattle have been known to produce around 1500 to 1800 liters per lactation under improved environmental conditions\textsuperscript{12}. There are several small dairy units in both Sudan and Eritrea who use the Bagait breed for intensive milk production under improved feeding conditions\textsuperscript{6}. Under highland conditions at altitudes above 1500 m, the Bagait have adopted very well and most small dairy units in the Eritrean city of Asmara (altitude of 1,700 m) rear Bagait cattle for milk\textsuperscript{13}.

Figure 1 shows the lactation curve for the first, second and third lactation. Second lactation showed the highest peak for monthly milk yield especially between the second and third months of lactation, followed by the first lactation, with the peak at the fifth months of lactation, which might have been attributed to the rangeland conditions resulting from draught. In three lactations, the milk curves started to decline from the fifth month of lactation. The results found in the present study is less than that reported on Ongole cattle\textsuperscript{9}.

The overall conclusion of this study is that, management, veterinary care and animal husbandry system play a great role in enhancing the genetic potential of the local breeds and the results are encouraging for the importance of more research in the management practices and animal husbandry in the pastoral system, as observed earlier\textsuperscript{14}.

References

Beni-Amer cattle herders have changed breeding standards to cope with war and drought. Bulletin No 31. Reading. U.K.


Received for publication on 21st June, 2004.
Figure 1: Sample Graph

Figure 1 shows the variation over time for the first, second, and third isolation. Suggestive indication showed the highest peak for monthly milk yield especially between the...
Late disposal age or long productive life is advantageous if it is accompanied by good levels of performance in other respects. Disposal age varies depending on criteria and type of predominant culling, origin of animals and breed differences\(^1,2\). Estimates ranging from 49.2 to 75.0 months are reported for Holstein-Friesian in the tropics\(^3,4,5\).

Disposal of high producing genotypes of temperate dairy cattle breeds are predominantly caused by infertility and diseases (fitness problems). This is because fitness traits are much more affected by the environment than production traits such as milk yield or weight. For instance, from Panama the chief causes of disposal in Holstein-Friesian were udder infection (30%), infertility (26%) and foot infection (20%)\(^6\). In the United Arab Emirates the main reasons for disposal of imported Dutch Friesian were brucellosis (50%), tuberculosis (13%) and infertility, while disposal for poor milk yield was only 3.0%\(^9\).

The herd in this study is a purebred Holstein-Friesian kept under semi-intensive management. Animal feed is largely grazing and hay with restricted supplementation. The herd was established in 1955 by importation of animals from the US, but this population succumbed and it neccesitated the importation of cattle of the same breeds four years later from Kenya.

In this herd regular vaccinations are given against as Rinderpest, Contagious Bovine Pleuro-Pneumonia, Blackleg and Foot and Mouth disease. Treatment for both external and internal parasites are done rather irregularly. Brucellosis, TB, Anaplasmosis and mastitis cases are rather common.

A total of 330 disposal records were used for the study for the period of 1974 to 1990. Disposal age was estimated by least-square analysis and a possible good effects of year and season of birth on disposal age were tested\(^7\). The following model was used for the study:

\[
Y_{ijk} = \mu + a_i + b_j + e_{ijk}
\]

where,

\[
Y_{ijk} = \text{observations of disposal age}
\]

\[
\mu = \text{overall mean}
\]

\[
a_i = \text{effect of year of birth on disposal age}
\]

\[
b_j = \text{effect of season of birth on disposal age}
\]

\[
e_{ijk} = \text{error or residual term - NID} \sim (0, \sigma^2)
\]

Least-square analysis gave an estimate for disposal age of 93.2± 0.3 months. This estimate is far higher than several estimates reported from the tropics which range from 49.2 to 75.6 months\(^3,4,5\). This apparently high disposal age would have been much higher if the predominant culling or disposal was voluntary. In this herd chief causes of disposals were infertility (25.7%) and diseases (9.8%). If deaths due to diseases were included disposals due to diseases would have risen to 31.0% (Table 1). These disposals were largely involuntary. Disposal for poor production and for poor genetic disposition were only 1.8 and 0.6%, respec-

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Table 1. Magnitude and per cent of cullings/disposals over disposal reasons.

<table>
<thead>
<tr>
<th>Disposal causes</th>
<th># disposed/culled</th>
<th>% disposed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infertility</td>
<td>85</td>
<td>25.7</td>
</tr>
<tr>
<td>Various diseases</td>
<td>32</td>
<td>9.8</td>
</tr>
<tr>
<td>Poor body condition</td>
<td>21</td>
<td>6.3</td>
</tr>
<tr>
<td>Abortion</td>
<td>11</td>
<td>3.3</td>
</tr>
<tr>
<td>Old age</td>
<td>11</td>
<td>3.3</td>
</tr>
<tr>
<td>Poor production</td>
<td>6</td>
<td>1.8</td>
</tr>
<tr>
<td>Breeding</td>
<td>2</td>
<td>0.6</td>
</tr>
<tr>
<td>Slaughter (due to various reasons)</td>
<td>22</td>
<td>6.6</td>
</tr>
<tr>
<td>Culled for unknown reasons</td>
<td>7</td>
<td>2.1</td>
</tr>
<tr>
<td>Deaths from diseases</td>
<td>49</td>
<td>14.8</td>
</tr>
<tr>
<td>Deaths from accidents</td>
<td>12</td>
<td>3.6</td>
</tr>
<tr>
<td>Deaths due unknown reasons</td>
<td>72</td>
<td>21.8</td>
</tr>
</tbody>
</table>

tively (Table 1). Yet this high disposal age is still important as it reduces cost of rearing of replacement animals and it increases the magnitude of economic returns of the female through a higher number of calves in her lifetime and increased milk yield as it matures. In addition, fitness performance of females namely stayability and fertility improves with age. For instance in this herd, calving interval showed a 7.6 days decrease per parity down parities which was very highly significant (P< 0.001)\(^8\).

Common causes of disposals in high producing temperate dairy cattle breeds are fitness problems (survival and fertility) similar to those found for this herd. For example, the chief reasons of disposals of Holsteins and Jerseys were diseases- udder infections (30%) and foot infections (20%) and infertility (26%) as reported earlier\(^8\). Similarly main causes of disposal in imported Dutch Friesians were diseases- brucellosis (50%) and tuberculosis (13%) and infertility (11%); while deliberate disposals due to poor yield amounted to 3.0%\(^6\), much higher than found from this study (1.8%).

Analysis of variance revealed that year of birth was a highly significant (P< 0.01) cause of variation of disposal age. Disposal age ranged from 95.6 to 128.2 months within the years of 1967 to 1976 and generally ranged from 70.2 to 95.5 within the years 1977 to 1983. A sharp drop of disposal age was noticed from 106.6 months in 1976 to 93.4 months in 1977 and it remained depressed in the following years. The year 1977 is the year when drought had prevailed in the country. The fall in disposal age and its depressions beginning 1977 was due to the effect of the drought and possible lowered health condition of the herd in that year and the years that followed. Conversely, the high records of disposals in earlier years was the far better management provided in those periods in terms of feed and health care. Disposal ages of terminal years were expectedly shorter because animals born in later years would be younger when they left
in the herd.

The disposal age found for this herd is beneficial because milk yield is known to increase with maturity of the female. The lifetime return of the female from number also rises with longer disposal age of calves. Cost of rearing females for replacement also reduces. High disposal age is also good or an asset if accompanied by good levels of management (especially feed and veterinary care) to both the growing and producing animals. We can therefore avoid importation of animals for herd expansion or establishments.

Acknowledgements

I extend my gratitude to Prof. Eskil Brannang from Sweden for his valuable comments and my thanks also goes to the Dairy Development Enterprise of Ethiopia for the supply of the data material.

References


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Table 1: Helminths recovered from 90 domestic pigeons in Nigeria.

<table>
<thead>
<tr>
<th>Organ</th>
<th>Species</th>
<th>Pigeons Infected (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proventriculus</td>
<td>Diaspis rhymesalis</td>
<td>10</td>
</tr>
<tr>
<td>Small Intestine</td>
<td>Ascarido columnae</td>
<td>60</td>
</tr>
<tr>
<td>Small Intestine</td>
<td>Raffilina spp.</td>
<td>16</td>
</tr>
<tr>
<td>Large Intestine</td>
<td>Ascarido columnae</td>
<td>50</td>
</tr>
<tr>
<td>Large Intestine</td>
<td>Raffilina spp.</td>
<td>10</td>
</tr>
</tbody>
</table>

*Corresponding author: 1: Email. alemanyala@public.net
References


...and many more...

In conclusion, the study of long-term survival and reproduction in...
SHORT COMMUNICATION

HELMINTH PARASITES OF DOMESTIC PIGEONS (COLUMBIA LIVIA) IN IBADAN, NIGERIA.

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2 Department of Veterinary Microbiology and Parasitology University of Ibadan. Ibadan, Nigeria.

Although reports have been published on the helminthes of pigeons in Africa1 there is no information about these parasites in pigeons in Nigeria. The birds are used mainly as a source of protein and traditional festivals. They are kept in wooden nest enclosures from which they manage to escape readily and may thus be considered as free-range birds. They are fed on the leftover human food and occasionally some grains. Internal and external parasites are very common as these pigeons are usually not treated for parasites2,3. As information was unavailable on the occurrence of helminth infections of domestic pigeons in Nigeria, necropsy examinations were carried out on some pigeons. The present paper reports the helminth parasites recovered from these birds.

Eighty domestic pigeons from different markets during the rainy months of June and July 2002 were examined. The birds were housed in a wire mesh enclosure. The pigeons were starved for one day before they were sacrificed by ether inhalation and necropsy performed. The respiratory and digestive tracts were separated. The digestive tract was separated into oesophagus, crop, proventriculus, gizzard, small intestine, caecum and large intestine. The contents of each were emptied into petri dish and the mucosae were washed thoroughly with tap

Table 1: Helminths recovered from 80 domestic pigeons in Nigeria.

<table>
<thead>
<tr>
<th>Organ</th>
<th>Species</th>
<th>Pigeons Infected (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proventriculus</td>
<td>Diphasynta spiralis</td>
<td>10</td>
</tr>
<tr>
<td>Small Intestine</td>
<td>Ascaridia columbae</td>
<td>65</td>
</tr>
<tr>
<td>Small Intestine</td>
<td>Railletina spp</td>
<td>91</td>
</tr>
<tr>
<td>Large Intestine</td>
<td>Ascaridia columbae</td>
<td>30</td>
</tr>
<tr>
<td>Large Intestine</td>
<td>Railletina spp</td>
<td>50</td>
</tr>
</tbody>
</table>

*Corresponding author E-mail: ioademola@yahoo.com
water and later on were scraped off with blunt edges of a scalpel blade. The materials were preserved in 5% formalin from which the parasites were collected, identified and counted.

Two nematode parasites, Dispharinx spiralis and Ascaridia columbae and a cestode Raillietina spp were identified (Table 1). No worms were present in the tracheae, oesophagi, crops and caeca. Dispharinx spiralis was found in the contents of the proventriculus but they were not associated with any mucosal lesions. Ascaridia columbae were mainly found in the small intestine. Raillietina spp were most common and occurred in both the small and large intestine in 91% of the pigeons. Lesions were found in some of the large and small intestine. Those pigeons with Ascaridia columbae were concurrently infected with Raillietine spp.

This study was an attempt to ascertain the prevalence of the species of helminth in pigeons in Nigeria. All pigeons studied harboured worms in the alimentary canal. Three helminth species were found. The helminth species collected from domestic pigeons may be considered as the first record in Nigeria. The Raillietina spp were most common because the pigeons were free-ranging and thus having access to the intermediate host of the tapeworm. The worm burdens were generally high as the birds were examined during the rainy months, when worm activity is high since helminth eggs develop faster in a warm and humid environment. All of these helminths may infest chicken and therefore pigeons should not be raised together with chickens or if they are raised together, a deworming regime should be established.

References


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Objet
Le Bulletin de la Santé et de la Production animales en Afrique contient des articles de recherches originales traitant d'activités en matière de santé et de production animales visant à assurer le développement de l'industrie animale et une meilleure utilisation des ressources du bétail en Afrique. Le Bulletin est un périodique trimestriel.

Présentation des articles
Deux exemplaires des articles doivent être adressés à Monsieur le Rédacteur en Chef, Bulletin de la Santé et de la Production Animales en Afrique, Union Africaine/Bureau interafricain des Ressources animales, P.O. Box 30786, 00100 Nairobi, Kenya. E-mail: ibar.office@au-ibar.org


Un article ne peut être soumis pour publication que s'il n'a pas encore été proposé ailleurs, il fera l'objet de quelques modifications par le Comité de Rédaction.

Genres d'articles publiés dans le Bulletin
- des communications originales.
- des brèves communications.
- analyse des articles proposés par le Rédacteur.
- des éditoriaux.
- le courrier des lecteurs.
- analyse d'ouvrages.
- informations et annonces.

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Les manuscrits doivent respecter les conditions suivantes: Le titre doit être concis et ne pas dépasser plus de 15 mots, il est suivi du (des) nom(s) de l'auteur (ou des auteurs) et des établissements où le travail a été effectué, ainsi que de l'adresse pour les correspondances si elle n'est pas la même.

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L'introduction expose le but de la recherche.
Le matériel et les méthodes utilisés.
Les résultats présentés brièvement.
Un débat sur l'importance de l'article.
Remerciements éventuels.

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